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POWER

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FEBRUARY, 1938

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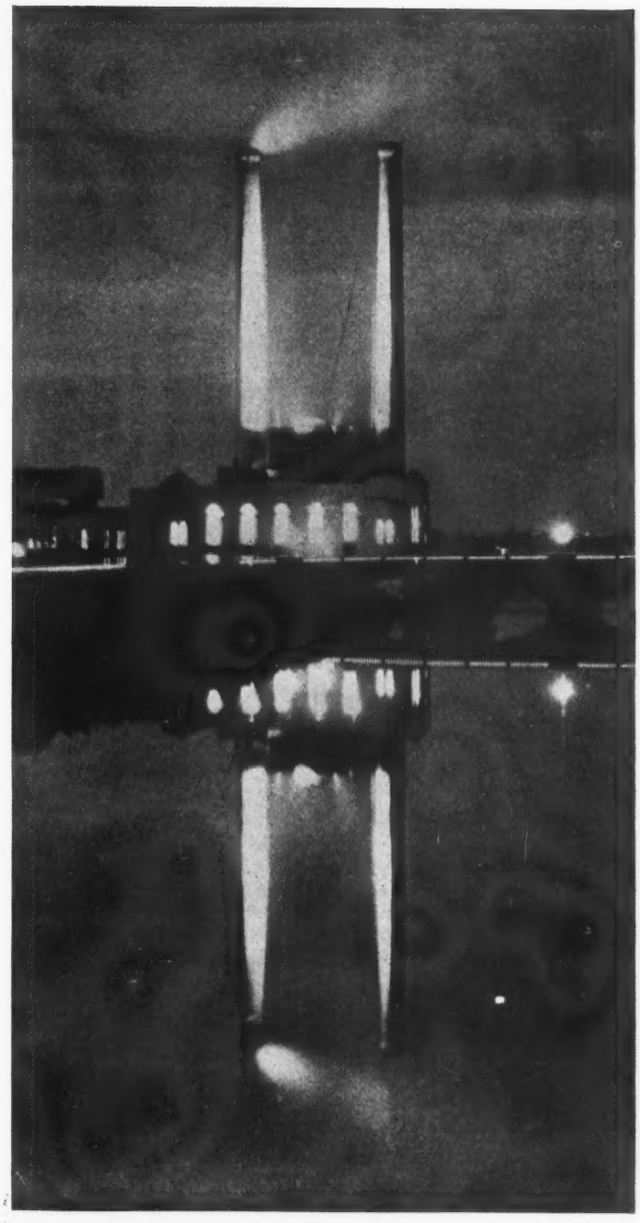
P O W E R
ESTABLISHED 1882

PHILIP W. SWAIN
Editor

SYMBOL



FURNISHING POWER and heat to one of America's great universities, this plant, bathed in light of its own making, symbolizes power repaying its great debt to education.

Today's power plants bear the stamp of countless years of study and experimentation, much of it within university walls. Still more do they reflect the achievements of thousands of college-trained engineers cooperating with those who learned the power technique "on the job."

But power has paid this first debt by returning to higher education a sizeable fraction of the immense wealth created by the machine age. In an age of handicraft, university training would necessarily be limited to a very small aristocracy, while the great mass of mankind struggled for a bare existence with shovel, hoe and sledge hammer. Nothing but an age of power-driven machines could have created a surplus of time and energy for the production of such wide-spread luxuries as mass education.

Thus education and power move hand in hand in an upward spiral. Education invests a fraction of its energies—a handful of potent seed—to perfect power technique and train new engineers. Backed with more basic knowledge and the energies of more trained men, power grows. It brings back to education a mere fraction of the increment, yet that fraction is far more than education's original investment in power progress. It's always that way when good seed is planted in fertile soil; a fraction of the crop exceeds the total sowing.

Already we start another circle of the upward spiral. Again the universities are devoting a fraction of their great power-won resources to mechanical, thermal and chemical research and to the solid training of young engineers. And again, if history is a guide, they may expect that their small share of the increment will far exceed their total investment.

41 Years of Power Progress At Landis Tool

Showing how thrifty investment policy, plus intelligent operation, keeps a typical American plant in step with advancing power technique

HERE is the condensed story of 41 years of progress in a typical American industrial power plant —a plant average in size, but better than average in its progressive policies. It starts back in 1897 with hand-fired hrt boilers and a Sweet "straight-line" engine out in the machine shop. It reaches 1938 with highly efficient pulverized-coal fired boilers, a 1000-cfm compressor and a total of 1200 kw in 4 engines.

A *Power* editor spent two days in this plant in late December, 1937, viewing the equipment, recording its history and observing today's operating results. The facts presented here are in no way sensational, but they do show how a thrifty investment policy, plus intelligent operation, can keep an average-sized plant in step with power progress. The plant serves Landis Tool Company, a pioneer and a present-day leader in the production of precision grinding machines for the metal-working industries.

Waynesboro, Pa., is the town. To fix it in mind, picture a neat old settlement of 12,000 people, centering around several modern metal-working plants—notably, Landis Tool Co, Landis Machine Co, and Frick Co. With famous Gettysburg 25 miles east and the Mason-Dixon line (Maryland) only 3 miles south, Waynesboro lies among the great battlefields of the Civil War. Travel 65 miles southeast and you are in Baltimore. It's 75 miles to Washington, D. C.

In spite of its southerly location, high altitude brings Waynesboro winter days as cold as 0 F; its factories require plenty of heating steam. And the water to make that steam won't scale boilers, they say, because it is practically pure rain coming down from the hills.

Started with a few dozen hands in 1897, Landis Tool today employs more than 1000. In the main these men are highly skilled mechanics recruited from

Fig. 1—Foreground: Engine-driven 2400-lb-per-hr pulversizer serves 5000-sq ft Keeler boiler. Behind, in order, are the 900-lb low-load pulverizer and a 2400-lb motor-driven pulverizer serving the Edge Motor boiler

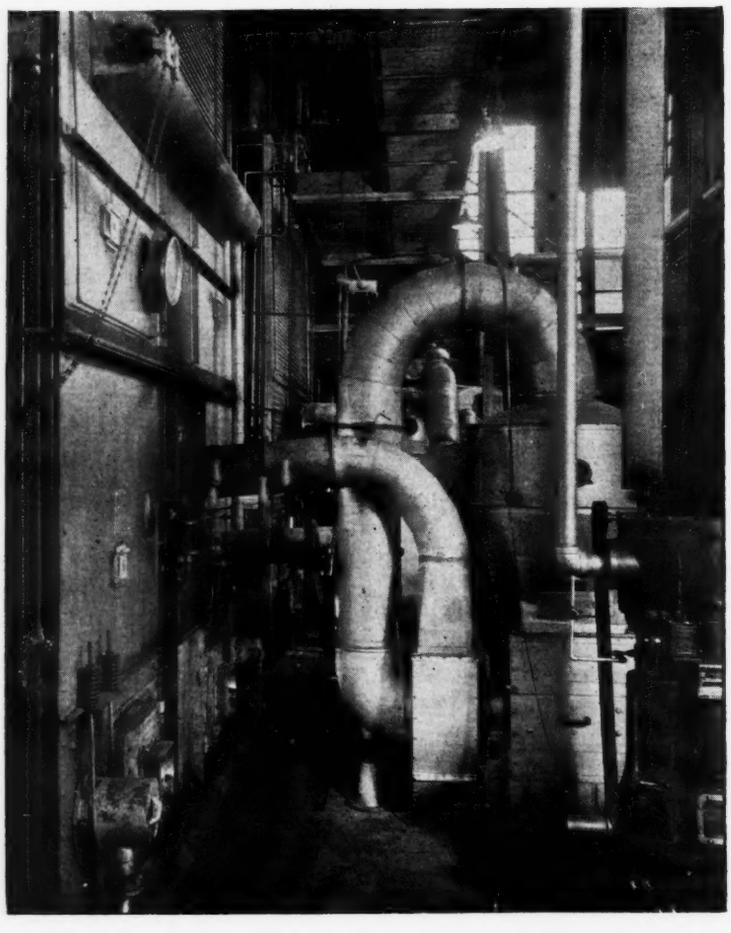
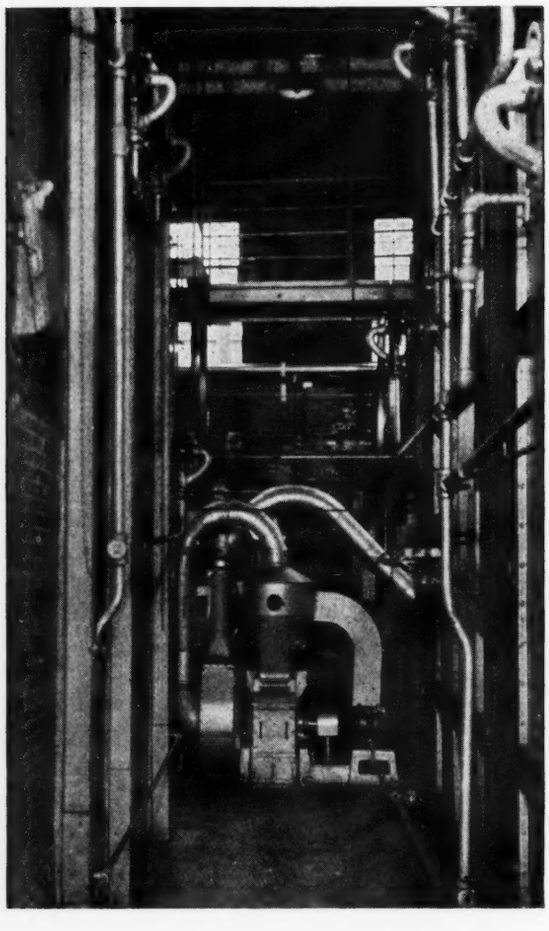


Fig. 2—Low-load pulverizer viewed from back of boiler room. Right, Keeler boiler; left, Edge Moor



the old American stock of the region. Young men graduate into the plant from a highly organized apprentice training course. Drafting room, offices and factory are thoroughly modern in both building and equipment.

Engine Room

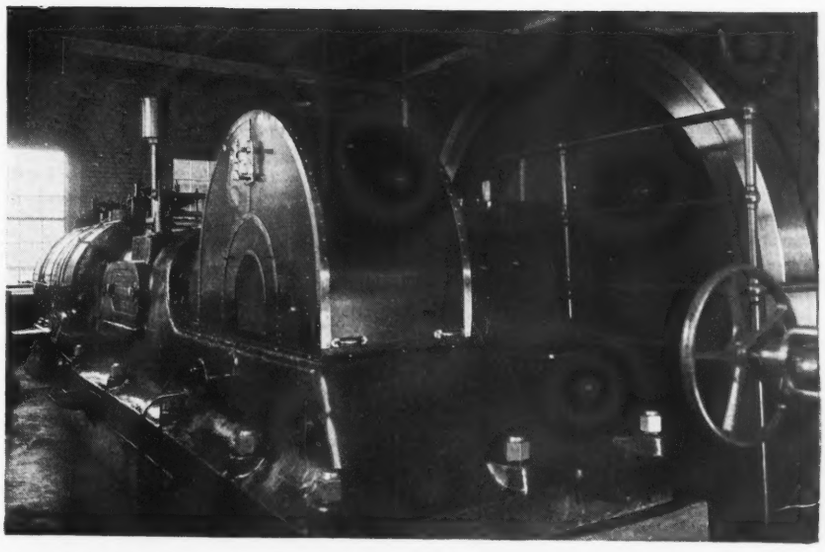
The starting point in 1897 has already been mentioned—one Sweet "straight-line" engine (100-lb pressure), a type still favorably remembered by many of the older power engineers around the country. The plant had no engine room then. The Sweet engine (we'll call it Unit *A*) stood in the machine shop, belted directly to line shafting.

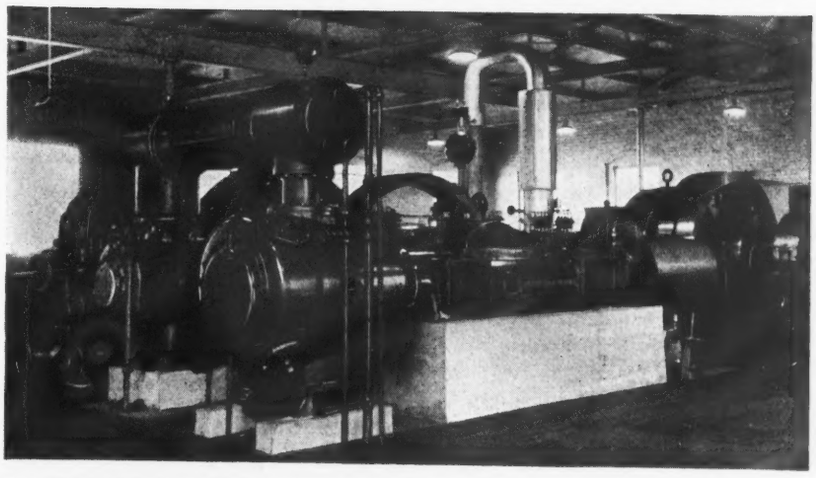
The "genealogy" of subsequent engines is tabulated on page 66, so we hit the high spots here: When a new power house was built in 1902, the Sweet engine was replaced by Unit *B*, a 200-kw Harrisburg. Steam pressure was hitched up to 125 lb. The new generator established the present electrical conditions of 220 volts DC, well adapted now, as then, to serve, over a reasonable radius, production machines requiring flexible speed control.

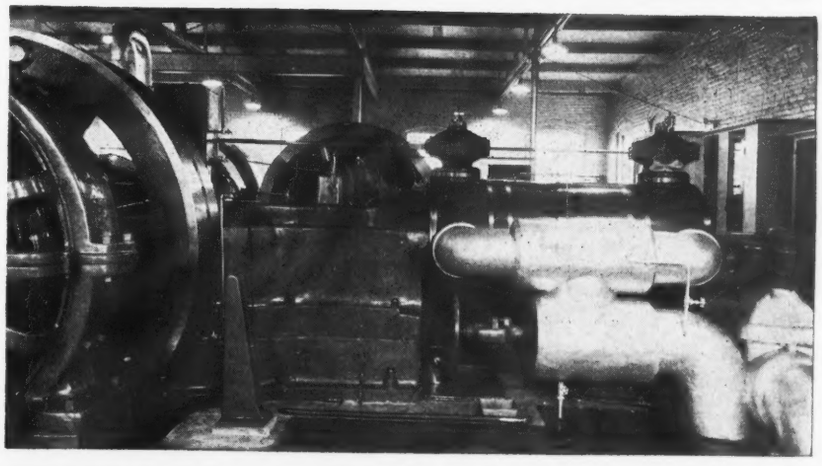
In 1904 came aonther 200-kw unit (*C*) and in 1910 a 100-kw unit (*D*). Altogether that made 500 kw in three Harrisburg units, two 4-valve engines and one piston-valve. Then came a long siesta of 23 years with no engines added. This spell was broken in 1933 when a new 500-kw Skinner uniflow (Unit *E*) doubled the plant's capacity. In 1935, the boiler plant was modernized and steam conditions on all generating units raised to 150 lb and 100-deg superheat. From there on, modernization and expansion proceeded rapidly.

Early in 1936 an attempt was made to cut costs by purchasing power, but the local power company could not offer power as cheaply as it was being made. In that year were installed three more units, a 1000-cfm cross-compound air compressor (Unit *F*), a 250-kw dc (Unit *G*) and a 312-kva ac (Unit *H*). This last supplies power for shop and office lights, testing tools equipped with ac motors, and also serves the ac motors driving coal pulverizers, with utility standby available for starting up.

In 1937 the 200-kw unit *B*, then 33 years old, was rebuilt, using the old piston with a radically different cylinder which gave it an efficiency nearly







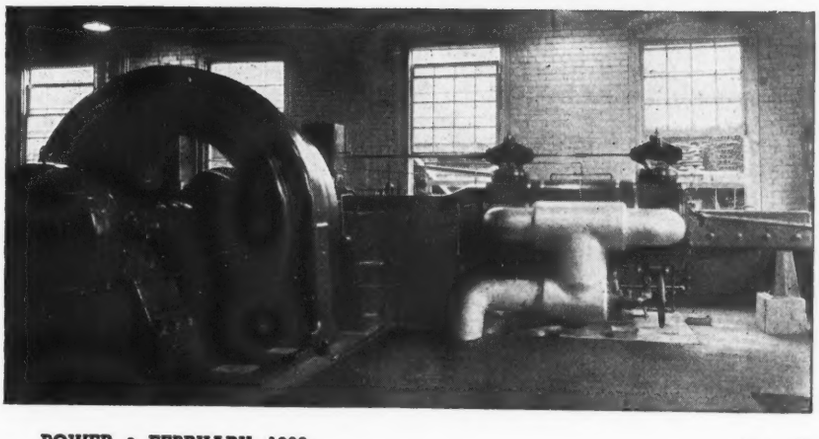


Fig. 3—Unit E, 500-kw Skinner

Fig. 4—Unit F, 1000-cfm Ingersoll-Rand compressor

Fig. 5—Unit G, 250-kw Ames

Fig. 6—Unit H, 312-kva Ames

equaling that of a new uniflow engine. Exhaust ports were moved in toward the center of the cylinder so that they were covered a full 2¼ in. by the piston at the end of the stroke. The idea was to leave a pocket of hot steam next to the cylinder head at all times, thereby keeping the head and cylinder end hot and reducing condensation at the next admission. The change cut the steam rate per bhp hr from 24 lb to 20, with throttle steam at 150 lb and 100-deg superheat and exhaust at 3-lb (these are present steam and exhaust conditions for all units).

As pointed out in the genealogy, units *G* and *H* were purchased as used machines, but revamped to first-class operating condition. Refitting of the double-disk poppet valves of unit *G* was an exacting operation, but one easily handled with the facilities available at Landis Tool. With a specially fitted fixture, double seats were machined true and coaxial, maintaining the original separation of the seats. Then the double disks were machined in a lathe and finally lapped against the seats to a tight fit.

Thus we bring the engine room to 1938 with a total of 1200 kw and 1000 cfm in 5 units, some modern, others modernized, all efficient and in smooth operating condition.

Steam Engine Genealogy

Unit A, 75 hp. **Installed 1897. Removed, 1904. Sweet "straight-line" engine belted to line shaft. Steam pressure 100 lb.**

Unit B, 200 kw, dc, 220 volts. **Installed 1902. Rebuilt, 1937. Harrisburg, 4-valve (non-release), 19 in. x 19 in., 200 rpm. Installed pressure 125 lb.**

Unit C, 200 kw, dc, 220 volts. **Installed 1904. Removed, 1936. Now in operation. Duplicate of Unit *B*. Installed pressure 125 lb; present, 150 lb and 100 deg superheat. In revamping, used old piston, but made new cylinder. Changed compression conditions for better efficiency.**

Unit D, 100 kw, dc, 220 volts. **Installed 1910. Removed, 1936. Harrisburg piston-valve engine, 13 in. x 15 in. 260 rpm. Installed pressure, 125 lb.**

Unit E, 500 kw, dc, 220 volts. **Installed 1933. Now in operation. Skinner uniflow, 27 in. x 36 in.; 150 rpm. Installed pressure, 125 lb; present, 150 lb with 100-deg superheat.**

Unit F, 1000 cfm compressor. **Installed Dec 1936. Now in operation. Ingersoll-Rand cross-compound, 2-stage with inter- and after-cooler. All strokes 14 in. Bores: steam, 12 in. and 21 in.; air 20 in. and 12½ in. Piston valve with hydraulically controlled riding cut-off on high-pressure steam. Pressures; air, 100 lb; steam, 150 lb with 100 deg superheat.**

Unit G, 250 kw, dc, 220 volt. **Installed Dec 1936. Now in operation. Ames uniflow, 23 in. x 24 in., 200 rpm. Steam 150 lb and 100 deg superheat. Bought second hand, but revamped with new crankshaft bearings, overhauled governor and refitted poppet valves (see text).**

Unit H, 312 kva, 220 volt, 60 cycle, 3 phase. **Installed Dec 1936. Now in operation. Ames uniflow, 21 in. x 24 in., 200 rpm. Steam 150 lb and 100 deg superheat. Bought second hand. Governor and steam valves revamped.**

Boiler-Room History

The boiler room, of course, had its parallel development, briefed as follows:

1897—First boilers installed. Two hrt, 60 in. x 14 ft, 100-lb working pressure.

1902—Removed original boilers. Built new boiler house. Installed two 72 in. x 18 ft Harrisburg hrt boilers, 125-lb working pressure.

1907—Added third hrt 72 in. x 18 ft, 125 lb, Coatsville make.

1911—Went "modern" with a 5000-sq ft Edge Moor water-tube boiler, 150 lb working pressure, stoker fired.

1936—Removed all hrt boilers and added a second 5000-sq ft water-tube boiler, a Keeler unit with water walls and superheater. This unit (built for 250-lb future pressure, but now operated at 150 lb) was fired from the start with pulverized coal. Before its installation, the boiler room floor was lowered 3 ft to give necessary furnace volume for pulverized fuel in both Edge Moor and Keeler units.

As it stands today, the Edge Moor boiler is set 14 ft above furnace floor. It is equipped with a Badenhausen radiant superheater and fired through one horizontal burner by a Strong Scott pulverizer (installed 1935), capacity 2400 lb coal per hr. The pulverizer is driven by a 25-hp ac motor, so it can start on utility

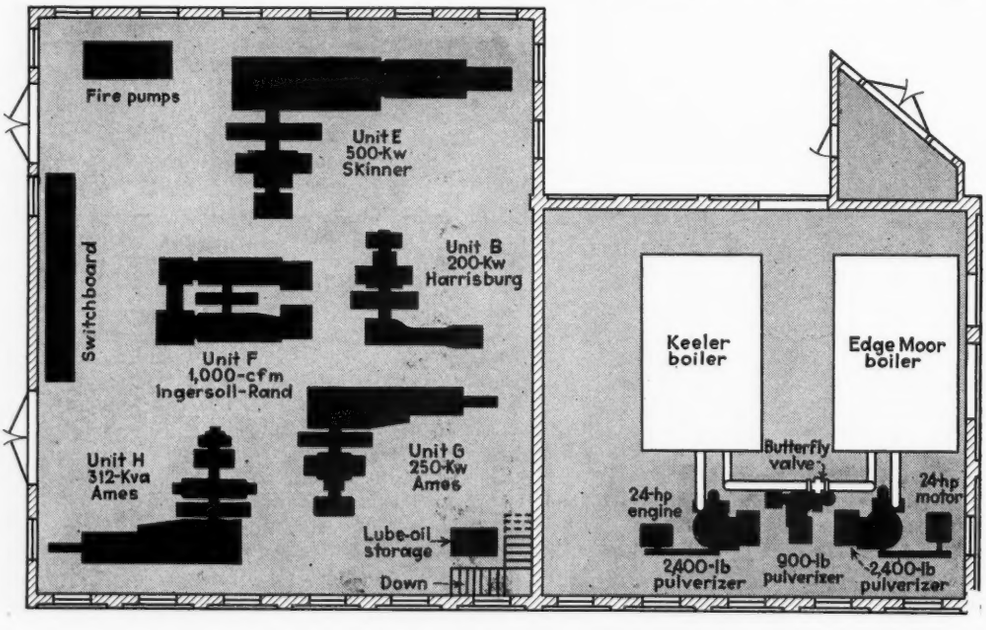


Fig. 7—

B 200-kw Harrisburg; installed 1904; rebuilt 1937

E 500-kw Skinner; installed 1933

F 100-cfm Ingersoll-Rand compressor; installed 1936

G 250-kw Ames; installed (rebuilt) 1936

H 312-kva Ames; installed (rebuilt) 1936

current if the plant is dead. Pulverizer and burner equipment are identical on Keeler, except that pulverizer drive is a 24-hp Troy engine (8 in. by 7 in., 400 rpm). This unit is water walled, on sides only, with bare tubes aggregating 800 sq ft. A convection-type superheater adds 100 deg to steam temperature.

Early in 1937 there was also installed a 900-lb-per-hr Strong Scott pulverizer with 10-hp ac motor drive. This is piped to special low-load burners on both boilers and can serve either through a butterfly switch valve. Normally only one boiler is operated at a time. The pulverizer combination permits operation from about 100 lb of coal per hr with the small pulverizer alone up to 3300 lb with both large and small. The 900-lb pulverizer is also useful in starting up, permitting a more gradual heating of boiler and setting. Generally the large burner is lighted from the small burner.

Fuel is high-grade bituminous. "Davis minus ¾ in. stoker coal" from Davis No. 38 Mine, Thomas, West Va. Properties are as follows:

Coal as received	
Btu	14,110
Moisture	3%
Dry-coal analysis	
Volatile	24.8%
Fixed C	68.1%
Ash	7.0%
Sulphur	0.8%
Btu	14,560
Btu, ash-and-moisture-free,	15,670
Ash softening temperature,	2920 F

Coal is dumped from hopper cars to track hopper, then bucket elevated to 10-ton hopper above Richardson automatic weighing scale which feeds the pulverizers directly through spouts. A paddle switch starts the elevator when hopper is nearly empty and stops it when bin is full. Scales automatically weigh and count 200-lb batches.

With this fuel and equipment, there is no smoke or slagging. Ash stays granular. Every three weeks, the boilers are alternated at Saturday noon. On the following Monday, men move a belt conveyor into the furnace of the dead boiler, then cool enough. Two men shovel the ash onto the conveyor, which discharges to a truck and is dumped to fill after being dampened. The cleaning job takes about 3 hours.

Buildings are heated day and night. From Sept 15 to May 30, inclusive, heating steam averages about 6,000,000 lb per month and power load about 500 kw and 700 cfm air by day, and 135 kw and 450 cfm at night. Practically no exhaust steam is wasted during cold weather. Process steam demands are practically nil, so almost all exhaust is wasted to atmosphere in summer. Thus the steam chargeable to power is about 5 lb per kw hr in winter, and about 30 lb in summer.

Steam-generating efficiency averages 82.5%, on basis of flowmeter readings of feedwater. This corresponds to an actual evaporation of 10.8 lb water per pound of coal. The cost of steam per thousand is 19.2¢ for coal and about 5¢ for labor and maintenance, a total operating cost of about 24.2¢.

In figuring the steam cost of power generation, boiler-room fixed charges may be omitted, because they would be practically the same if the boiler room served heating only. Thus the steam cost of power per kw hr is about 1.2 mils in winter and 7.3 mils in summer. Adding engine-room labor and maintenance and supplies, and fixed charges not yet written off on engine-room equipment, the total power cost is about 7.1 mils per kw hr in winter and 13.2 mils in summer.

Makeup in summer is practically 100%, although neither feed treatment nor chemicals are used. The extremely pure mountain water used has caused no visible scale, but some rust in feed lines.

The regular feed pump is a 2-stage centrifugal driven by a 25-hp motor, with a steam-driven reciprocating pump as standby. Heating returns, vacuum pump and standby are reciprocating units.

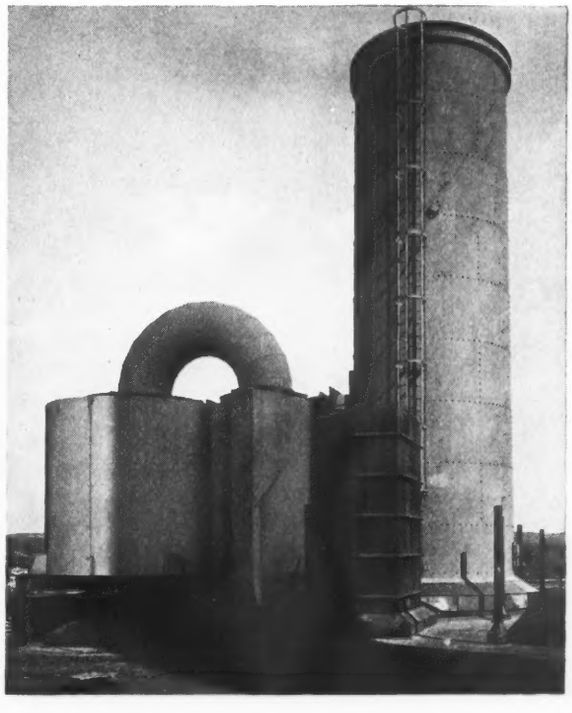
Meters and Instruments

The following meters and instruments are now in operation: 1 Brown Instrument Co flowmeter, measuring total feedwater to boilers. 1 Brown flowmeter, measuring steam to air compressor (large receiver installed to smooth pulsations). 1 Brown CO_2 recorder arranged for switching to either boiler and provided with an eye-level indicator for the fireman. 2 Brooke Engineering damper regulators. 1 Brooke Engineering pulverizer control. This regulates all 3 pulverizers. Individual pulverizers can be regulated by hand if operator desires. 1 Ellison draft gage for "over-fire" draft.

Dust Collector for Fly Ash

THIS DRY-TYPE dust collector is on the roof of the Montville plant of the Connecticut Light Power Co, but the flue gas is cleaned before passing through the induced draft fans. The inlet of the primary concentrator is equipped with a ring of pivoted vanes, which are operated by the combustion-control system. At fractional loads, they maintain uniform rim velocity in the primary concentrator. About 15% of the gas is shaved off the volute casing and passes to the secondary stage carrying the fly ash. The secondary cyclone discharges the dust to a pneumatic conveying system.

In the background is the 50-ft steel stack described in January POWER, page 6.



Safe Pump Control on 4000 Volts

Control for three 4000-volt, vertical, synchronous-motor-driven sewage pumps, totally inclosed in steel cubicles, provides flexible operation plus safety

By M R Brice
APPLICATION ENGINEER
CUTLER-HAMMER, INC.

PUMPING EQUIPMENT at the new sewage-treatment plant, Green Bay, Wis, is a good example of design that combines operating convenience and reliability with neat appearance and safety. Three vertical centrifugal pumps raise incoming sewage to a level high enough to carry it through the treatment plant. Provision has been made for a fourth pump. Each pump is direct coupled to a vertical synchronous motor with direct-connected exciter. Motors are rated at 50, 75 and 150 hp, unity-power-factor, and operate on a 4000-volt, three-phase, 60-cycle power supply.

Electrical control for incoming lines, power and lighting transformer banks and synchronous motors, is of the cubicle type, entirely enclosed and dead-front construction throughout. The entire enclosure is constructed of ⅛-in., all-welded, stretcher-levelled steel, with doors front and rear. The contro cubicle is made up of five individual units, mounted together, but each complete in itself and separate from the others except for the high tension power bus that runs through all the units.

Each section, or unit, of the control cubicle contains four compartments, each separated from the other by steel walls, and each accessible through its own door. Each upper rear compartment contains the 4000-volt power bus and a 3-pole gang-operated disconnect switch. By opening the upper rear door, the operator has access to the disconnect-switch-operating lever, but is still protected, by means of a steel plate, from contact with live parts. A lower rear door of each unit gives access to the oil circuit breaker and current transformers. All high-tension power lines are confined to the two rear compartments. An upper front compartment of each unit contains potential transformers and potential transformer fuses.

Lower front compartments of the incoming-line control section and the transformer-bank control section contain manual operating levers for the oil circuit breakers. Doors to these compartments must be opened to permit operating the breakers. In the lower front compartments of the motor-control units are low-voltage control panels containing field contactors, control relays, etc. All meters, meter switches, induction-type overload relays, control switches and field-rheostat-operating handwheels are mounted on the doors of the lower front compartments, and are wired with flexible connections so that they swing out with the doors.

Electrical Interlocks

Every precaution is taken to make sure that the operator cannot accidentally come in contact with live high-tension parts. Electrical interlocks are so arranged that when one of the upper rear doors is opened for access to a disconnect-switch-operating lever, the circuit breaker in the control unit is automatically opened. This makes certain that the disconnect switch cannot be opened under load.

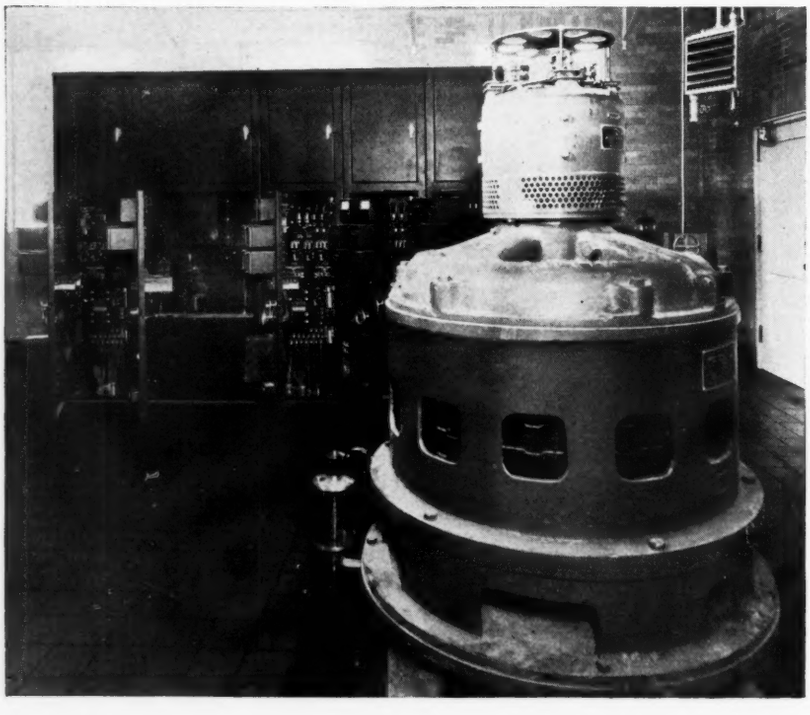


Fig. 1—Control for incoming lines, power and lighting transformer banks and synchronous motors is of the cubicle type, entirely enclosed and dead-front construction

Fig. 2—Normally, two multi-contact float switches start and stop the pumps automatically according to sewage level in the wells

A mechanical interlock makes it impossible to open the top front or lower rear doors, which cover high-voltage parts, until the disconnect switch has been opened. The disconnect switch cannot be reclosed until both of these doors are closed. The lower front doors are not interlocked. It is often desirable to have access to the parts here enclosed without shutting down the equipment, and no serious hazard is involved.

Normally the pump motors are automatically started and stopped according to the level of sewage in the well. Two multi-contact float switches control the three pumps and provision has been made for control of a fourth pump when installed. Heavy-duty cam-operated float switches have hardened-steel rollers riding on large hardened-steel cams. The heavy silver-to-silver double-break contacts have no flexible connections. Transfer switches permit starting or stopping any of the pumps manually under pushbutton control. Under automatic float-switch control, low-voltage release is obtained and under manual pushbutton control, low-voltage protection is obtained.

Pump motors and control are designed for full-voltage across-the-line starting. Main contactors are magnetically-operated oil circuit breakers. A 48-volt lead storage battery with rectifier-type charger (separate from the control cubicle) furnishes direct current to operate circuit breakers and other control devices.

Frequency-relay method of synchronous-motor acceleration, Fig. 3, is used. For the sake of simplicity, this diagram shows only the fundamental connections and does not show the various interlocks, safety features, and meter connections which are included in the control. Referring to this diagram, pushing the "start" button energizes control relay *1CR* through contacts of voltage relay *VR*, thermal overload relay *OL* (coil circuits not shown) and thermal timing relay *TS*. Relay *1CR* maintains itself and closes the oil circuit breaker *M*, applying full voltage to the stator of the motor.

Closing the line contactor causes a current at line frequency to be induced in the field winding of the motor. This current flows through the normally closed contact on the field switch *FS* through the discharge resistor *FD* and then divides, part flowing through the reactor coil and part through the frequency-relay coil *FR*. Coil of relay coil *FR* has a low reactance at line frequency, compared to the high reactance of the reactor coil, so that sufficient current flows through relay coil *FR* to pick up its armature immediately, opening the normally closed *FR* contact in the coil circuit of field switch *FS*. The field switch does not operate at this time because there is no voltage across the circuit until the direct-connected exciter comes up to speed.

Accelerating Cycle

As the motor accelerates, frequency of the field-discharge current decreases. When the motor reaches a speed approximating 95% of synchronous speed, frequency of the field-discharge current is so low that the reactor coil provides a circuit of low impedance compared to that of the relay coil *FR*. As a result a greater portion of the field-discharge current flows through the reactor, so reducing the current in the *FR* relay coil that its armature drops out and closes the relay contact. This completes the circuit to the field-switch coil *FS* to close the field contactor and applies excitation to the synchronous-motor field, at the same time opening the field-discharge circuit. This completes the accelerating cycle.

As long as the motor runs in synchronism, direct current flows through the low-resistance reactor coil and a negligible amount of it through the relay coil *FR*. Should the motor be pulled out of synchronism because of a momentary overload or voltage dip, ac of low frequency is induced in the motor-field winding. The ac is impeded by the reactor with the result that enough current flows through relay coil *FR* to open its contact to de-energize field contactor *FS* and remove excitation. This causes the motor to operate as a squirrel-cage induction motor.

If the voltage and load conditions return to normal so that the motor can again accelerate, *FR* relay functions in the normal manner at the correct speed, applying field excitation and opening the field discharge circuit, just as on a regular start. If the overload continues or if the low-voltage condition continues, either the overload relay *OL* or the thermal timing relay *TS* will stop the motor before it is damaged.

The frequency relay embodies in one device the means for synchronizing, removing field excitation and resynchronizing. Relay *FR* is responsive at all times to the electrical conditions of the field circuit, since the reactor and the frequency relay coil are continuously in the motor-field circuit.

Thermal timing relay *TS* operates to stop the motor and prevent burnout of the squirrel-cage winding in the rotor pole faces. The average squirrel-cage winding is safe for a 30-sec start. A thermal timing relay adjusted to shut down the motor if acceleration is not completed in 30 sec, therefore, provides adequate protection to the squirrel-cage winding.

A field-failure relay serves to shut down the equipment in case of field-current failure. A timing relay on

the field contactor introduces a short-time delay to permit the field current to build up before the field-failure relay becomes operative.

Each motor controller is interlocked with the hydraulically operated valve at the discharge of its pump. The motor is started with the discharge valve closed, but as soon as the motor comes up to speed a solenoid operated pilot valve is energized, admitting water to the hydraulic cylinder and opening the discharge valve. If the "stop" button is pressed or if the motor is to be stopped under float switch control, the solenoid operated pilot valve is deenergized and the valve closes. When the valve is nearly closed it operates a limit switch to trip the circuit breaker and stop the motor. This operation causes the least hydraulic shock on the system and permits the motor to start unloaded. If the motor is to be stopped because of overcurrent, field failure, or door-interlock operation, indicating an emergency condition, the motor is stopped immediately without waiting for the discharge valve to close, though the valve starts to close at once.

This article outlines the equipment of the main sewage-pumping station. A somewhat similar auxiliary station is also in operation in Green Bay, but is not included in this description.

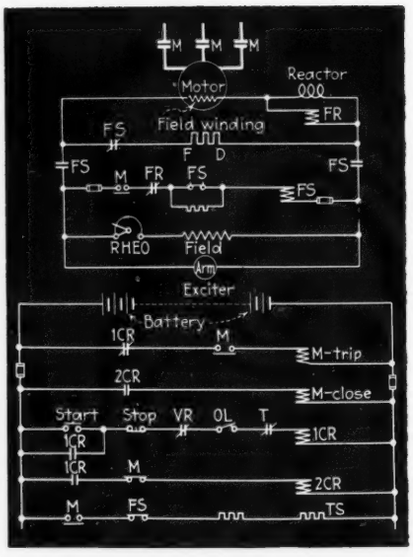


Fig. 3—Fundamental connections of the frequency-relay method of synchronous-motor acceleration used in the control system

Less Oil Wasted— More Lubrication

Elevator oil room for storing and handling lubricants pays dividends in cleanliness, fire-hazard elimination and effective lubrication

By William Devaughn

CORRECT LUBRICATION is essential to elevator operation. First, there is selection of the proper oil or grease and second, delivery to the bearings without contaminating the lubricant. Too frequently the latter is neglected; high quality lubricants are purchased, delivered in sealed containers, but after they are received, all thought of protecting them from dirt, moisture and other contaminants is forgotten.

At the Bank of Manhattan Building, 40 Wall St., New York, N. Y., we operate 46 elevators, some of which run from the street level to the 60th floor. Consequently, correct lubrication of this equipment is very important, because it affects quality and safety of the elevator service as well as cost of maintenance. Lubrication neglect may necessitate shutting down elevators when they are badly needed and cause expensive repairs.

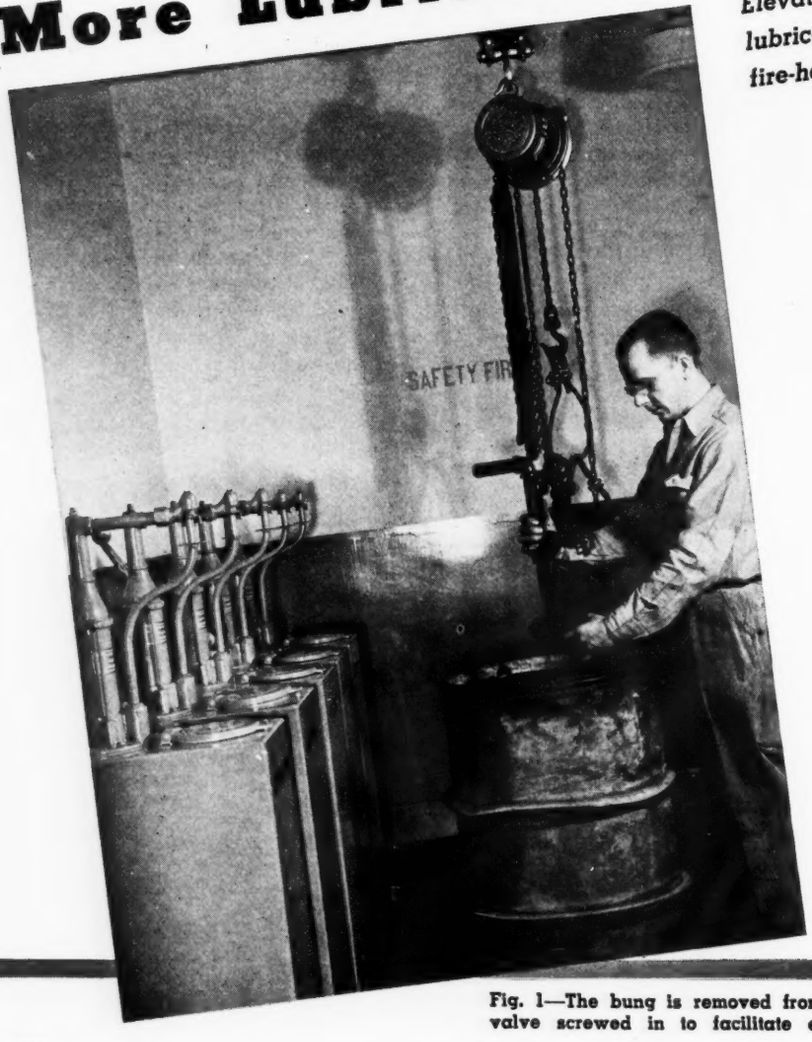


Fig. 1—The bung is removed from the oil drum head and a pipe nozzle with valve screwed in to facilitate emptying oil into the various storage tanks

Realizing the importance of this problem, we decided that if we were going to purchase high-grade lubricants, we should protect them and use them intelligently. To make sure that lubricants will reach the bearings in as good condition as received, an oil room has been built in the stores department, on the 11th floor. This room is kept locked at all times, and no one has access to it except men who do the lubricating. In this way, we can insist upon absolute cleanliness in this room and place responsibility for any infraction of this rule.

Rules are not generally difficult to enforce when proper provisions are made to meet their requirements. This is the principle we incorporated into our oil room. Everything within reason has been done to simplify the handling of lubricant and prevent spilling.

A 55-gal. tank with a measuring pump is provided for each of four kinds of lubricating oils and one for kerosene used for cleaning. The lubricants include motor oil, gear oil, guide-rail oil and buffer oil. We are now gradually overhauling the buffers in the elevator pits and renewing the oil. When this job is complete, the buffer-oil tank may be used for cable oil or any purpose that may seem desirable.

The five tanks are set into an oil-tight tray made of heavy galvanized sheet metal to confine any slight leaks or spills. Building an oil room on a concrete floor in an office building presents a serious problem, as oil will penetrate the concrete floor and stain the ceiling below. As a preventative, the entire floor and the lower 6 in. of the side walls were made oil tight with galvanized sheet metal soldered at all joints. This covering has also been painted. A ½-in. steel plate 3 ft wide and 8 ft long protects the floor covering at the door where oil drums are rolled in.

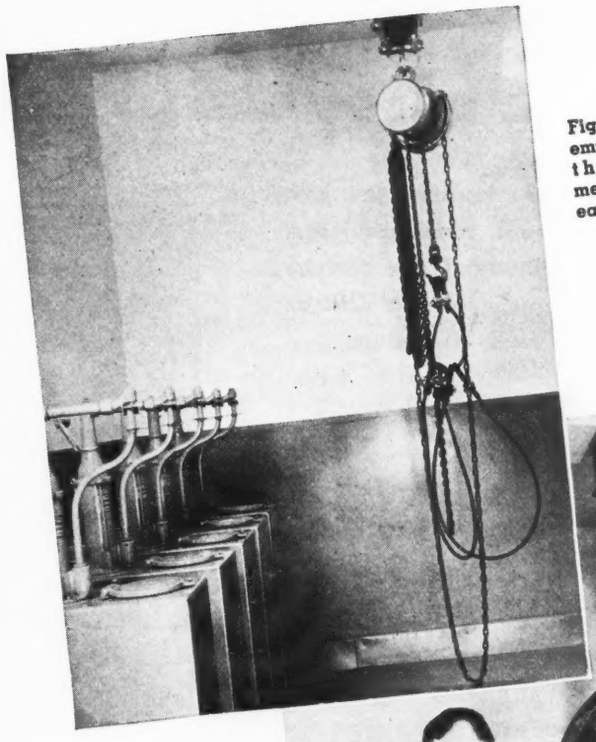


Fig. 2—A chain fall empties oil drums into the tanks with a measuring pump for each kind of oil

Fig. 3—A drum is easily lifted by the chain fall and oil flow into a storage tank controlled by the valve

Lifting Device

A 50-gal. drum of oil is rather difficult to empty without an efficient lifting device. This problem was solved by installing on the ceiling a 6-in. I-beam on which runs a 1000-lb chain fall and trolley. The beam is bolted to the building steel and is curved to center one end over the door, so that the trolley and chain fall can be brought to that location for lifting the oil drums. The chain fall has two wire-rope slings, one to slip over each end of the oil drum.

To empty an oil drum, which is generally done shortly after it is received, the drum is cleaned on the outside and rolled inside the oil-room door. There the head bung is removed and a pipe nozzle with a valve screwed into the bung hole. With the valve closed, one sling is slipped over one end of the drum, which is then turned over on its side to bring the side bung to the top. The other sling is put over the drum, the side bung loosened, the drum lifted by the chain fall and transferred to the tank where it is to be emptied. When the nozzle has been properly located to empty the drum into the oil tank, the valve is opened. From then on, the oil flows without fuss, dirt or effort. After a drum is emptied, it is returned to the oil company as soon as possible so that the stock room is kept free of oil and containers.

As explained in December *Power*, page 725, a system of loud-speaker phones provides direct communication to all motor rooms and other strategic points on the elevator system. An attendant is on duty at all times at the five master phones to answer all calls. This attendant keeps the elevator log and also the record of oil delivered to the oil room and how it is requisitioned out, what for and by whom.

This system has been in operation a few months but it has already proved to be a good investment. More efficient and effective lubrication, insurance against oil contamination, cleanliness, elimination of fire hazard, and improved morale of the mechanics, who pride themselves on making our elevators models of cleanliness and good operation, have paid dividends.

Watch Your Air Gages!

AIR PRESSURE, building up in the case of a defective gage on a compressor tank, burst the glass and shattered fragments were blown into the operator's face. The gage indicated 210 lb. As gage cases are usually required to be airtight and moisture proof, some kind of safety plug should be provided, and gages should be tested regularly.

Sensible Sizes for Sheaves, Pulleys, Sprockets, Gears

A common-sense guide for choosing the best diameter of the drive element, considering first cost, efficiency, dependability and low maintenance. Covers sprockets and gears, as well as flat-belt pulleys and Vee-belt sheaves

By B S Weaver
INDUSTRIAL DEPARTMENT
GENERAL ELECTRIC CO

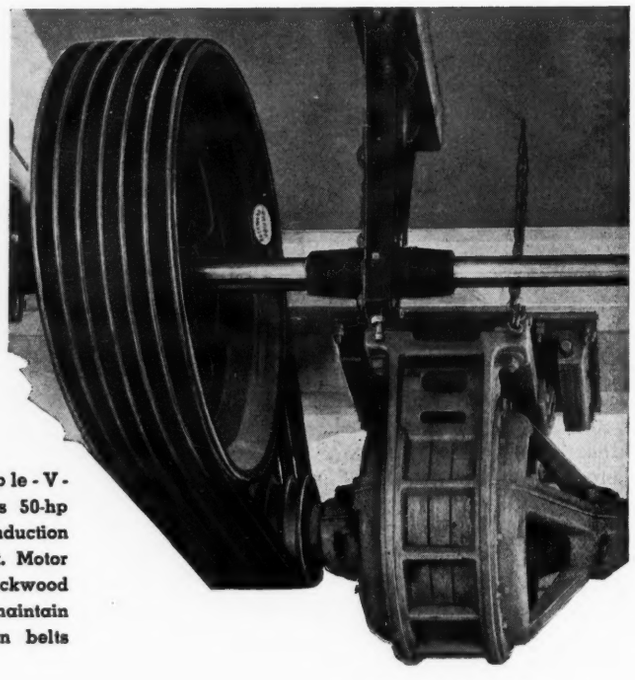


Fig. 1—Multiple-V-belt drive connects 50-hp ceiling-mounted induction motor to line shaft. Motor mounted on Rockwood pivoted base to maintain constant tension in belts

"SIZE up Your Pulleys", page 21, January *Power*, showed what factors place upper and lower limits on the diameter of pulleys for flat belts. It showed how to find these limits in practice and how to choose wisely within the permissible range of operations.

The present article will extend this same treatment to multiple-V-belt sheaves, chain sprockets and gears. For these many of the same principals apply, but with decidedly different constants and certain additional considerations.

Belt Tension

Let's review, very briefly, this matter of tensions: With flat belts tight-side tension is taken as 3 times slack side, so that total pull on pulley is 2 times the power pull. With V-belts, tight-side tension is assumed to be 7 times slack side, so that total pull on sheave is only 1.33 times load pull. Sheave diameter can therefore be reduced, in proportion, to $1.33 \div 2 = 0.66$ the diameter of pulleys for flat belts. This "two thirds" rule is generally used where V-belt sheave-face widths do not exceed the pulley widths recommended for flat belts.

For sheaves and sprockets, as for flat-belt pulleys, belt or chain tensions place a lower limit on diameter. Too small a pulley or sheave leads directly to overloaded motor bearings, excessive belt maintenance and other troubles. Too great diameter, on the other hand, means that the belt or chain will operate at excessive speed.

There is a tendency to operate V-belts as tight as flat belts. Resulting bearing loads then may exceed allowable maximum and cause failure. This situation has improved greatly in recent years, through educational efforts of V-belt manufacturers.

Neglecting chain weight, a chain-drive sprocket on a motor shaft may be treated as the pinion for a gear drive when determining allowable pitch diameters and overhung loads. Chain weight may require consideration on slow-speed vertical drives when the motor is mounted above the driven shaft and supports practically the entire weight of the chain. For normal drives, with chain weight divided between driving and driven shafts, bearing loads are not appreciably increased.

Bearing Loads

Bearing loads imposed by a properly adjusted chain are those necessary to transmit motor torque, or only 0.5 those for flat-belt drives. On this basis, pinion-pitch diameters may be reduced to one half flat-pulley diameters without exceeding allowable limits for bearing loads.

The table below gives maximum horsepower ratings recommended by the National Electrical Manufacturers Assn, for 2-bearing motors connected to their loads by flat belts, multiple-V-belts, chains or gears. For quiet operation and freedom from severe vibration, pinion peripheral speed at the pitch diameter should not exceed 1300 fpm with cut-steel spur gearing.

With a belt, chain or gear drives on motors of horsepower ratings above those allowed for two bearings, an outboard bearing may be used to give a 3-bearing construction. For belted or chain drive, the assembly includes the outboard pedestal bearing base and belt tightening rails. For gear drives, the outboard pedestal bearing only is furnished unmounted.

General principles for belt, chain, and gear drives applied to motors also hold for gearmotors. In addition there are specific problems depending upon shaft speeds, overhung loads, bearing spacing, etc. Gearmotor output-shaft speeds range from approximately 600 down to 10 rpm on chain and gear drives and directly coupled drives. Output speeds available make it possible to obtain approximately the desired speed for direct coupling. For other applications, where further speed reduction is required, or where it is not advisable to drive directly through a coupling, output-shaft speed may be chosen to give the greatest over-all economy in total reduction from motor shaft to driven load.

Gears

Inasmuch as chain and gear drives predominate, recommendations for minimum sprocket and pinion pitch diameters are listed by the motor manufacturers following each rating.

The listings are based on load application at a point midway along the shaft extension. In comparable speed ratings of gearmotors and slow-speed motors without gears, the gear motor will usually have the larger sprocket or gear because of shorter spacing between supporting bearings of the output shaft. For reasonably high output shaft speeds, where multiple-V-belts or flat belts may be recommended, the listed sprocket diameters may be used for determining minimum allowable sheave or pulley diameters. V-belt sheaves should be at least 1.33 times, and flat-belt pulleys, at least double the listed sprocket diameter with the center of load applied in the same location on the shaft as for the sprocket.

Drive Dimensions

Diameters larger than the allowable minimum are not objectionable, since bearing loads decrease proportionally with increase in diameter. Sometimes it is possible to use a wider face with the load center moved out from the midpoint of the shaft extension, but such applications require special investigation. Limit of face width is reached when load center approaches the shaft-extension end, making the face width approximately twice that dimension.

For reasonably high-speed drives with the reduction gear overhung on and supported by the motor structure, motor feet must have ample strength to withstand side loading. For lower speeds it becomes necessary either to provide additional feet on the output end shield, or to provide feet on the gear housing and overhang the motor. With the former, the gearmotor is mounted on a sub-base, which, in turn, is mounted on a belt-tightening base. In Fig. 2 the gearmotor with roller chain drive has supporting feet on the gear end shield and supporting plate for connecting to a tightening base. A gearmotor with feet provided on the gear housing so that the motor can be overhung, connected to its load by a chain drive, is shown in Fig. 3.

Summary

Shaft and bearing loadings produced by belt, chain and gear drives are dependant upon shaft size, spacing between bearings, and point of load application. This loading differs for flat belts, multiple-V-belts, chain and gear drives. For flat belts the total pull is approximately 2 times full load pull; for multiple-V-belts it is 1.33 times; for chain (disregarding chain weight) and gears, 1.

Allowable bearing loading for sleeve bearings depends upon bearing area and rubbing speed. For anti-friction bearings, the manufacturer's recommendations are used in determining allowable loading.

Minimum diameters for driving pulleys, sheaves, sprockets and gears are determined from the center of loading on the shaft extension, allowable bearing loading, which represents the total pull, and the ratio of total to tangential pull.

Maximum face widths of pulleys or pinions are limited to approximately twice the distance of the center of loading from the bearing housing, and may vary approximately from shaft-extension length to approximately twice that value, depending upon whether recommended standards or special recommendations are followed.

Maximum face widths and minimum diameters are closely related and must be considered where loads are critical.

Maximum pulley and pinion diameters are limited by allowable peripheral speeds as recommended by the transmission manufacturer.

Minimum face widths are most often specified by the drive manufacturer and have no great effect on the motor problems.

Limits for chain and gear drives for motors have been established quite generally by the motor manufacturers as a group, but are subject to some modifications as they become necessary.

Similar limits for gearmotors have been established by each gearmotor manufacturer, but no general standardization has been worked out by the group as a whole. A general standardization is hardly possible until such time as gearmotor speeds and mounting dimensions have been agreed upon.

NEMA Recommendations for 2-Bearing Motor Maximum Ratings for Flat Belts, V-Belts, Gear or Chain Drives

	Motor Speed and Horsepower					
Motor Speed	1,800	1,500	1,200	900	720	600
Flat Belts, Hp	40	40	75	125	150	200
V-Belts, Hp	75	75	125	150	200	
Gears and Chains, Hp	5	10	25	50	75	

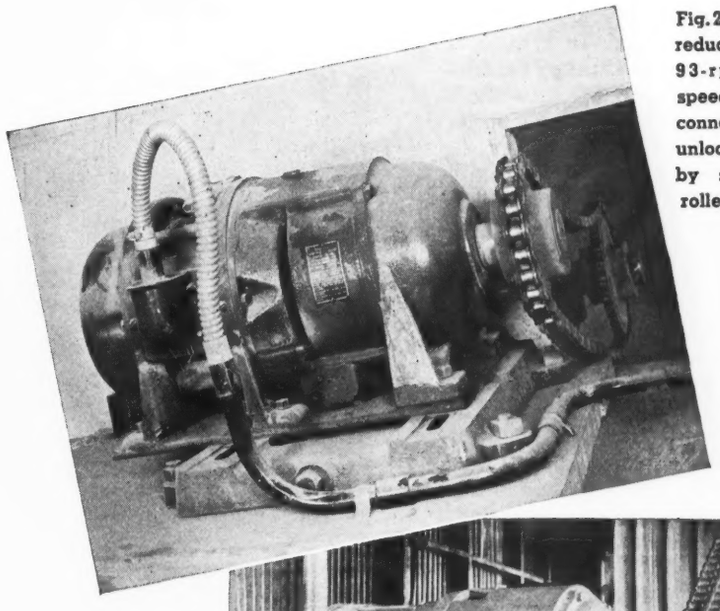


Fig. 2—Compound-reduction, 7.5-hp, 93-rpm output speed gear motor connected to car-unloading shovel by single-strand roller-type chain

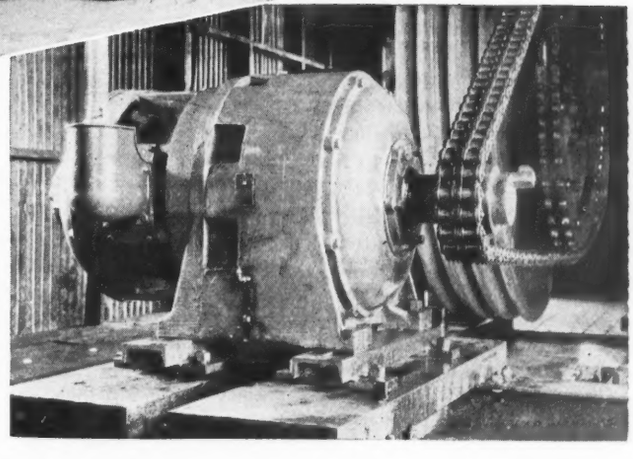


Fig. 3 — Triple-rated, 40-, 28-, or 16-hp, 90-rpm output speed gear motor connected to beam oil pump by double-strand, roller-type chain

Precise Frequency Control With Reverse-Flow Governor

An ingenious development in governor construction improves frequency control of central-station current

By O N Bryant
WESTINGHOUSE ELECTRIC & MFG CO

NOT MANY YEARS AGO, users of central-station electric power were well pleased when frequency was kept within a half-cycle variation on a 60-cycle system. Widespread use of synchronous electric clocks has not required closer control of frequency, since error in time results only from an accumulated average departure from standard frequency, easily corrected during night hours by manual regulation.

Talking-movie projectors and electric phonographs, however, when driven by synchronous motors, create a more difficult problem because the human ear is sensitive to extremely slight changes in pitch. If off-pitch notes are not to intrude on your movie program, the motors driving the film or recording must maintain constant instantaneous speed within precise, narrow limits. In turn, governors of power-producing turbines must be sensitive to the same small changes in frequency. Many electric-power systems now limit variations to a maximum of $\frac{2}{10}$ cycle; some are holding normal operation to within $\frac{1}{10}$ cycle.

Steam turbines are controlled by governors that respond to speed changes. An ideal governor, theoretically perfect, would maintain exactly constant speed regardless of the rapidity or magnitude of load changes. This would require that the instantaneous torque produced by the steam flowing through the turbine be always exactly equal to the instantaneous torque required by the generator load. Since a momentary difference between these torques will produce a speed change, an ideal governor must measure acceleration rather than speed, and produce instantaneous readjustments of steam supply to load.

Various more-or-less successful combinations of load-responsive, speed-responsive and acceleration- or inertia-responsive governors have been developed. For all practical purposes, however, a speed-responsive governor can be made to give satisfactory results. In all cases, a speed governor must be provided to hold the average speed at its proper value. Inertia-responsive and load-responsive elements are, by their nature, auxiliary devices for combination with a speed governor. Satisfactory performance of the entire governor system is largely dependent on the quality of the speed governor and its quick-acting servomotor which controls the motion of the steam-admission valves.

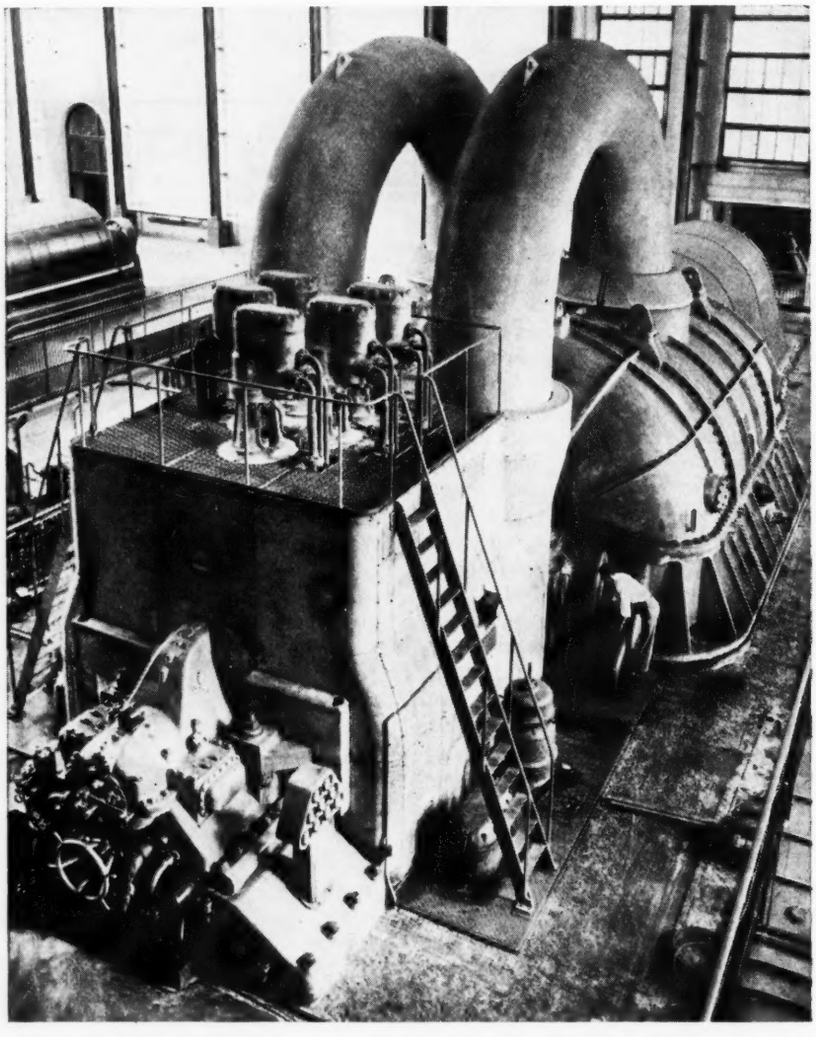


Fig. 1—165,000-kw turbine-generator controlled by reverse-flow impeller governor

To approach ideal governing, a speed-responsive governor must: (1) measure the speed exactly, (2) respond to extremely minute variations in speed, (3) have a servomotor system which can move the steam admission valves at a rate proportional to the acceleration of the turbine, and (4) be able to close the steam valves

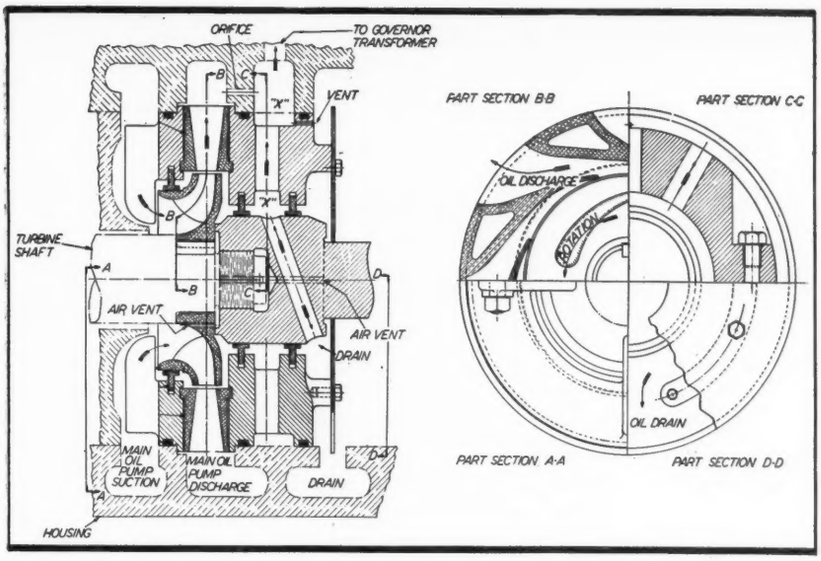


Fig. 2—Arrangement of main oil pump and governing impellers in the improved oil governor

quickly enough in event of sudden loss of load to avoid operation of the overspeed trip mechanism.

About 15 years ago, a hydraulic governing system (H F Schmidt) was applied to industrial turbines. The governor operates on the principle that the discharge pressure of a centrifugal pump varies as the square of its rotational speed. A centrifugal pump, mounted directly on the turbine shaft, produces a supply of lubricating oil at about 70-lb pressure which serves the dual purpose of actuating the servomotor and moving a pressure-responsive governing relay. The speed of the turbine determines the oil pressure and the servomotor is controlled in response to this pressure.

Versatility

The hydraulic governing system is notable for its freedom from wear and for the ease with which several servomotors can be made to respond to speed changes and to changes in pressure in extraction or exhaust lines. Pipes replace the intricate system of levers, rockshafts, and connecting rods, of conventional design.

Success with industrial turbines led to the adoption of this governing system for large central-station turbines. Large units require so much oil for lubrication and servomotors that two separate oil pumps are required: one to supply high-pressure oil and another to produce a speed-responsive pressure for governing. Two pumps are used because sudden changes in the rate of lubricating-oil flow cause fluctuations of the discharge pressure of a centrifugal pump. With a single pump, these would affect governing to some extent. This effect was avoided in small industrial turbines by using a radial-vaned impeller with a very low radial velocity.

Recently, the advantage of the 2-pump hydraulic governing system has been enhanced by an ingenious development. The former large governing impeller which had a 10-lb inlet pressure and discharged at 80 to 90 lb has been replaced by an orifice and annular space. Referring to Fig. 2, a small amount of oil from the high-pressure pump is discharged through an orifice into the annular space *X* surrounding the turbine shaft. A hole drilled through the shaft at an angle, connects space *X* with the drain chamber at the end of the shaft. At first glance, one might suppose that it would be impossible to build up any pressure in *X* because of the large size of the hole in comparison to the size of the orifice. However, when the shaft rotates at its normal speed, centrifugal force acts upon the oil passing through the hole in the shaft. A counter-pressure of about 40 lb is produced in chamber *X*, which varies as the square of the rotational speed. If the high-pressure pump discharges at a pressure higher than 40 lb, some oil will flow through the orifice into *X* and thence through the hole in the shaft to the drain chamber.

Reverse Flow

The exact pressure in chamber *X* depends upon three factors: (1) counter pressure due to rotation of the shaft, (2) resistance to the flow of oil into and through the hole, and (3) pressure in the drain chamber. The drain chamber is vented to atmosphere, hence its pressure will be constant. The hole through the shaft is large for the rate of oil flow; consequently the resistance to flow is negligible. Thus the counter pressure caused by the rotation of the turbine shaft is the only factor of any real significance upon which the governing pressure in chamber *X* depends.

Extended laboratory tests on the governor followed by field operation in central-station turbines have shown these operating advantages:

(a) No friction, nor measurable inertia, with consequent accurate measuring of turbine speed.

(b) Accuracy does not diminish, because there are no parts to wear.

(c) No more power is required than for an equal length of smooth journal, an important consideration when used with the small-size turbines. In fact, it may be built into one of the main journal bearings, and the oil which would normally leak past the sealing rings lubricates the journal.

(d) The sensitivity of this governor is great, permitting the use of a very quick-acting servomotor to operate the steam-admission valves. Thus steam flow is constantly being corrected to suit momentary load changes upon the generator. Very close control of frequency is the result.

Large Turbines

This governor is used on a 165,000-kw tandem-compound turbine-generator, Fig. 1, in which each of the seven admission valves has its own servomotor. Five are on the top of the turbine cylinder, while the other two are on either side of the turbine just below the floor line. Because of relatively long pipes leading to each of the pressure-responsive relays of the servomotors, it was felt that inertia of the operating fluid (a non-inflammable oil) might cause too great a time lag for good control if the governing pressure were used directly. A pressure-responsive relay is interposed which amplifies pressure variations from the governor about ten times. Inertia forces become negligible by comparison and any slight friction in the servomotor relays becomes of less significance.

A small central station required a turbine with a constant-speed, or so-called "isochronous" governor so that the frequency could be controlled more accurately with less attention on the part of the operator. One of these improved governors was installed, which, when tested recently with a high-speed frequency recorder, was found to be holding the frequency within 1/20 cycle, a close approximation to ideal governing.

HP	Max. RPM	Max. Piston Speed, FPM	Stroke-Cycles	BMEP	Injection	Cost of Specs	Engineer	Date	Purchaser
450	NS	1000	4	75	S	$0	Own	9–27–35	Standard Oil of Cal.
375	*NS	*NS	2 or 4	NS	S or A	10	Burns & McDonnell.	9– 4–35	City of Villisca, Iowa
120–160	Alt. 500	NS	2 to 4	NS	S or A	15	G M Orr & Co	11– 1–34	Village of Preston, Minn.
270–310	†360								
1100 Total 3 units	400	1000	2 or 4	NS	Mech.	25	Burlingame & Hitchcock	12–27–34	City of Morris, Minn.
(2) 500 ea	327	1100	NS	NS	Mech	....	Own	June '35	Thief River Falls, Minn.
950–1000	400	1100	2 or 4	80–4 cy 60–2 cy	S	20	E T Archer	8–27–35	City of Burlington, Kansas
150	514	1150	2 or 4	NS	NS	5	W A Fuller Co	8–12–35	City of Louisiana, Mo.
(2) 135 to 150 ea	400	1100	2 or 4	80–4 cy 60–2 cy	S or A	20	E T Archer	4–30–35	City of Pattonsburg, Mo.
(2) 275 to 300 ea	400	1100	2 or 4	80–4 cy 60–2 cy	S or A	....	E T Archer	11–23–34	City of La Plata, Mo.
250–350	375	1000	NS	NS	NS	....			Wessington Springs, S. Dak.
600	360	NS	2 or 4	NS	S or A	5	Black & Veatch	11–12–35	City of Blair, Nebraska
750	360	NS	2 or 4	NS	S	0	Jos Breslove	11–18–35	Village of Arcade, N. Y.
450	360	NS	2 or 4	NS	S	0	Jos Breslove	11–18–25	Village of Arcade, N. Y.
300	360	NS	2 or 4	NS	S	0	Jos Breslove	11–18–35	Village of Arcade, N. Y.
300	360	NS	2 or 4	NS	S or A	2	Black & Veatch	12– 2–35	City of Burlingame, Kan.
1200	400	1100	2 or 4	NS	NS	20	W B Rollins & Co.	12–20–35	City of Hoisington, Kan.
600–525 or 450	400	1100	NS	80	Mech	25	Young & Stanley	12–12–35	City of Eldon, Iowa
490–600 Dies. 600–490 Gas	400	1000	NS	80	Mech	25	Young & Stanley	12–10–35	City of Ogden, Iowa
500	400	1100	2 or 4	80–4 cy 60–2 cy	Mech	10	Burlingame & Hitchcock	1–10–36	City of Benson, Minn.
200	450	1000	4	NS	Mech	10	W R Holway	2–25–36	City of Shawnee, Okla.
600	300	1100	4	75	Mech	0	Panama Canal	9–10–36	Diesel-Electric Tug
350	300	NS	2 or 4	80	Mech	0	Lighthouse	10–30–36	Supt. Lighthouses, Norfolk, Va.
75 and 150	600	1100	2 or 4	75–4 cy 40–2 cy	Mech	10	T C Smith	11–19–37	Orcas Island — REA
400 and 600	360–327	1100	2 or 4	78–4 cy 68–39–2 cy	Mech	25	Young & Stanley	10–19–37	City of Waverly, Iowa
225 and 450	400	1100	2 or 4	75–4 cy 40–2 cy	Mech	10	Allen Sickler	9–14–37	Surprise Valley, Calif.—REA
3–350	400	1100	2 or 4	NS	S or A	5	Burns & McDonnell	8–15–34	City of Kennett, Mo.
250–400–600	400–360	1060	2 or 4	76	S or A	NS	P M Anderson	5–19–37	Shenandoah Valley — REA

NS — Not Stated *A — Air Injection*
Mech or S — Solid or Mechanical Injection

* "Shaft and piston speeds shall not be excessive."
† Minimum speed 240 rpm. In no other case was a minimum specified.

Recent Diesel Specs Show Rise in Piston Speed, BMEP

By E J Tangerman
MANAGING EDITOR

POWER has at various times remarked the continuing tendency toward higher piston speeds and higher brake mean effective pressures in diesel-engine plants, large as well as small. Concrete evidence of this is indicated by the accompanying tabulation showing some 27 recent specifications, mainly municipal, during the past three years, covering engines from 75 to 1100 hp each. Preferences of various consulting engineers, as indicated in these specifications, show surprisingly little variation.

Take piston speeds as an example. Up to six or seven years ago, the upper limit for stationary plants was 900 feet per minute in most cases, no doubt based on the old U S Navy specifications. Four or five years ago, that limit began to rise, first reaching 1000 fpm, then 1100. Note particularly that many recent specifications set no maximum piston speed whatsoever, and of those which do, the majority specify 1100 fpm, without distinction according to size. Also most engineers specify either 2- or 4-stroke cycle, except in seven cases, four of which mean the same thing because they do not specify either. Of the remaining three, the chances are that at least two specify 4-cycle because previous engines in the same plant, or in other similar plants, are of that type.

In only eight cases is a choice allowed between solid and air injection; the rest specify solid or mechanical injection arbitrarily.

Permissible maximum brake mean effective pressures are also rising, in many cases not being specified at all, and in the remaining instances usually being 80 lb for 4-cycle engines and around 60 for 2-cycle pump-scavenging engines, a rise of about 10 lb per sq in. over the upper limits of a few years ago.

The advent of the Rural Electrification Administration has encouraged many small communities to build municipal diesel power plants. Often these are engineered by local consultants having little or no previous diesel experience. The resulting variation will probably eventually require the REA to determine and specify maximum factors to be recommended to engineers on REA specifications. At the present writing, such maximum factors would appear to be: Maximum fpm piston speed, 1200. Maximum brake mean effective pressure for 4-stroke cycle engines, 80 lb; for 2-cycle pump-scavenged engines, 70–75 lb; and for 2-cycle crankcase-scavenged engines, 45 lb.

Planned Electrical Maintenance Keeps Trouble Away

How one plant has eliminated shutdowns of electrical equipment by a system of daily, monthly and yearly scheduled maintenance

By K B Humphrey

Multiple-V-belt connects 150-hp. 2400-volt motor to large fan

MUCH HAS BEEN SAID and written about planned maintenance, about making regular inspections daily, monthly, or yearly. The do's and don'ts have been many, but engineers agree that this is a subject that cannot be over-stressed. Here is a concrete example of electrical-equipment maintenance born not of theory, but of experience.

In this plant, frequency of inspection is determined by type and importance of the equipment and service conditions. For example, on a 275-hp, 2400-volt synchronous motor, with direct-connected exciter, belted to a line shaft driving a group of machines, daily inspections cover bearings, temperature, ammeter readings, slip rings and exciter commutator.

The inspector looks at the ring-oiled bearings to make sure that rings are turning and that enough oil is being supplied to bearings. Temperature may be noted by hand; after a little experience, abnormal temperatures can be detected in this way. The dc ammeter in the field is read to see that it indicates 15 amp (this reading gives the desired system power factor). If the operator does not adjust the rheostat properly, the inspector makes any changes necessary to bring the field current to the proper value and notifies the operator.

He then checks motor load by the ac-ammeter readings and wipes off the commutator and slip rings with a soft rag. He notes and corrects sparking, chattering, or anything unusual about the brushes and commutator. The motor is inspected daily when in operation; other maintenance work is done after the plant is shut down or on Sundays.

Monthly Inspections

Once every month, but not necessarily on the same day, oil switches are inspected, commutator and slip rings checked, equipment is cleaned, insulation tested, and the belt dressed. Oil tanks on the switches are dropped for inspection of oil and contacts. Free carbon, formed when the switch is opened, gradually blackens the insulating oil. If carbon content appears high, oil should be changed. Otherwise it is usually changed once a year. The mechanical parts of the switch are checked and bearings lightly lubricated. Insulating bushings are wiped clean. Burned contacts are replaced and the old ones taken to the shop to be reconditioned if they are not irreparably damaged.

The motor and exciter are thoroughly cleaned, first by blowing out accumulated dust, then by a thorough wiping off. Slip rings, commutator and brushes are inspected. The exciter commutator is dressed with a fine stone if it shows signs of uneven wear; otherwise only fine sandpaper is used. All brushes are removed and inspected and any copper particles removed from their surfaces. After dressing the commutator, brush rigging is lightly lubricated so that it works freely, and holders are cleaned. Brushes are then returned to position and the motor started.

Insulation of stator, field coils, exciter, and switches is checked with a megger. A minimum reading of one megohm per 1000 volts is considered safe on the high-voltage wiring and coils, with a minimum of one megohm for the exciter and field coils. The 22-in. leather belt connecting the motor to the drive shaft is given a light coat of dressing both inside and out. This work is usually done on a Saturday, so that the dressing soaks well in before the motor is operated.

As mentioned before, these various maintenance details are not usually handled on the same day. Oil switches may be taken care of on one day and the belt dressed on another. A written record helps to keep various parts of the maintenance schedule spaced at approximately one month intervals.

Yearly Inspections

On yearly inspections and maintenance, oil is changed in switches and in bearings, bearing wear is checked by measuring rotor air gaps, field rheostats are cleaned, and all equipment is given a general going over. If the plant has no oil-testing facilities, oil in the switches is changed at least once a year.

Once a year, lubricating oil in the bearings is changed and bearings are thoroughly flushed out and checked for wear. Clearance between the main stator and revolving field is quite large, but on the exciter it is small. Therefore, it is necessary to base bearing changes on exciter clearance rather than on other factors. The field rheostat is taken apart and its contacts cleaned. Wiring is inspected and all bolts and screws tightened.

No provisions for major repairs have been considered in this inspection schedule. From daily, monthly and yearly inspections, the machine's condition is pretty well known at all times so that a general shop overhaul can be put off until required. For several years, this plant has not had a single motor shutdown traceable to maintenance neglect.

EXHAUST LINES

By E J Tangerman

An old shipboard trick worth remembering concerns ammonia leaks. You can blow an air hose into an ammonia-filled room all day without much result, but just try a water spray for a few minutes! There's nothing ammonia gas likes better than water. The same holds true for chlorine gas; in that case the water forms a little chlorine water, normally preferable to chlorine.

America's shortest railroad, 4.6 miles long, runs between Cassville and Exeter, Mo. Dave Dingler is president, chief engineer, owner, and staff. He makes three round trips a week, hauling coal, wood, fruit and an occasional passenger.

70,000 tons of gasoline and 20,000 tons of byproducts are to be extracted from coal annually by the Rhine-Prussia Corp's new plant. It is of course a major link in Germany's rearmament plans.

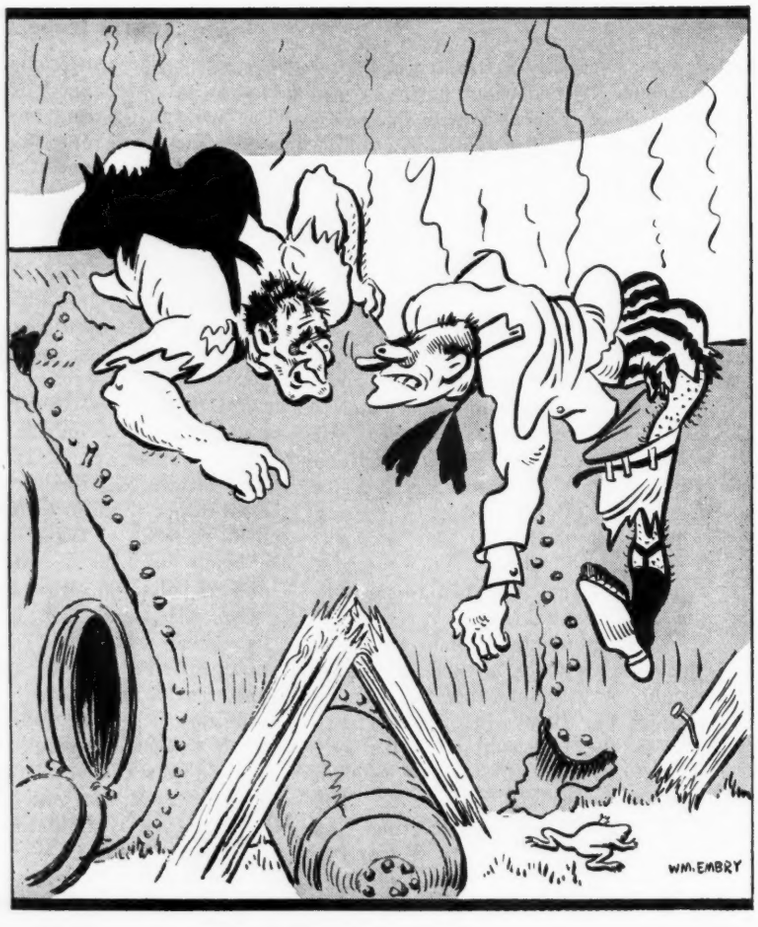
Hindenburg Hall of the Krupp Works, Essen, Germany, is the world's largest manufacturing building. It is 1,000 ft square. During the World War, 7,000 men worked there making artillery; now 3,500 work there making locomotives.

Diamond miners find one carat per 4 tons of mined rock. Half of that is fit for commercial use only, another quarter is off color. The remaining quarter includes many small stones; only an occasional one weighs a carat. All in all, the waste volume to get a flawless 1-carat diamond is one half a billion times as small as the stone.

Whatever makes a gasoline engine run smoothly, ethyl fluid for example, makes a diesel knock, and vice versa. Tetra-ethyl lead is added to gasoline to slow down combustion, because too sudden a burning causes a knock. But in a diesel you want the fuel to burn as soon as it enters the cylinder.

A parrot was sitting in the salon of a luxurious liner watching a magician do his tricks. Said the magician, "Now I'm going to perform a trick never before accomplished." As he rolled up his sleeves and began his fancy gestures, the ship's boilers blew up. Five minutes later the parrot came to, floating on a piece of driftwood. He spied the magician struggling in the water and muttered, "Dam clever, dam clever!"

"But, Chief, the water level you saw was painted on —the real one bounced so much we couldn't read it!"



To speed up a train from a 40-mph to a 60-mph schedule means a 227% power increase. What will that do to railroad power plants after electrification?

Germany's self-sufficiency program is leading to the use of all sorts of waste materials. Large trucks utilizing sewage gas stored in metal tanks holding about 500 cu ft at 400 lb are becoming common. The sewage of 40 German cities is now treated for the gas, discovered to have a 50% higher thermal value than city gas and a methane content of 70 to 80%.

Last year, General Motors alone turned out something like 200 million horsepower in automobile engines, while total diesel production was just under two million. At that rate, what are the limits to diesel prospects? Incidentally, GM's output was 40% of the total.

Dan Gutleben, chief at Pennsylvania Sugar, Philadelphia, has just told me the one about the Camden, N. J. woman wine-maker who wouldn't accept his company's sugar from her grocer because she said that since Pennsylvania Sugar extracts alcohol from the sugar it makes, she prefers other brands which may improve the strength of the wine. That's byproduct power for you!

Although turbines and direct diesel and diesel-electric drives have been installed in many new ships, the older reciprocating engine is still the first love of marine engineers. A. R. McMullen, superintendent of machinery for Federal Shipbuilding & Drydock Co., recently suggested these sentiments in his poem, "The Reciprocating Engine."

You may rave of turbine engines,
You may rant of diesel drive,
You may make them all electric
And expect them to survive.
But have you stood beside the throttle
With your eye on boiler gage,
Have you watched the crossheads racing
As the tempests roar and rage?
Have you heard the pistons whizzing
Through a forty-eight inch stroke,
Have you seen the main links bucking,
Like a mustang never broke?
Have you seen eccentrics prancing
Like a stallion full of life,
Have you heard the air pump heaving,
Like a wrestler in the strife?
There is music there, and gladness,
There's a lilt to lift the soul,
There is power and dependence,
Though it comes from oil and coal.
With her heads all clean and polished,
And her paint all gleaming bright,
With her gages at two hundred,
She's a grand ennobling sight.
They can build them out in Egypt,
They can fix them in Japan,
For reciprocating engines
Are as old as any man.

THE BRASS TACKS OF AIR CONDITIONING

IN plants for heating and cooling the power engineer has for generations been bending the weather to his will. For a quarter century, at least, he has rounded out this weather-making job by removing dust and fumes, adding or subtracting moisture. The only new thing about "air conditioning" is today's common acceptance of the name and its appeal to the popular imagination.

With this romantic view the engineer need not quarrel. Enough for him that the public has found a name for something everybody wants, something he alone can supply. In things mechanical, the engineer has never yet failed his public. He has amply supplied the insistent demands for heat, light and power, for water supply and refrigeration, for transportation and means of communication. If now the public demands complete air conditioning, he must stand ready to fill the need as a matter of course. As far as the engineer is concerned, air conditioning is just another job to be done right at minimum cost.

Aiming to serve every power engineer, *Power* faces this problem with him. For a starter, the special section of April, 1936, made it clear that air conditioning is simply a recombination of elements long familiar to the engineer.

In this number we propose to get down to the brass tacks of application. What is the nature of the space to be conditioned—theater, office, department store, auditorium, hotel, industrial establishment? How big is it? When and how is it occupied? What is the net effect desired? How is this expressed in units of temperature, humidity, air purity? What do these require in terms of heating, cooling, air movement, control, etc? The air conditioning job must be done with commercial equipment, so what's available? What principles determine the selection, combination and positioning of these elements? The fifteen pages that follow review the fundamentals and show what equipment is available. They outline the principles of unit selection and combination, with specific examples of applications in more important fields.

Finally, because every cautious engineer must learn from his neighbor's experience, they present data on 400 air-conditioning installations all over the United States. Based on a survey made with the active cooperation of many manufacturers of air-conditioning equipment, they include a great variety of applications and every combination of elements likely to come up for consideration. The only limitation is size—a lower limit of 50 tons equivalent refrigeration to permit concentration on those larger installations which make the greatest demands on the skill of the power engineer.

THE JOB

Air conditioning calls for regulation of temperature, humidity, cleanliness, ventilation, and circulation. In these two pages, the job and its pattern are outlined, and some fundamentals are condensed for quick review

AIR CONDITIONING is a 5-point job, involving the maintenance of the temperature, humidity, cleanliness, ventilation and circulation best suited to comfort and health.

Most important from the standpoint of comfort are temperature and humidity, but opinion is divided as to the exact conditions desired. Actually each case is different; one must consider local customs and climate, length of stay and activity of the occupants, outdoor conditions, and the investment and operating cost required to maintain a given set of conditions.

Air conditioning attempts to remove as much foreign matter as is economically possible. Some cases, such as treatment of respiratory troubles, require the maximum cleaning physically possible (including removal of invisible pollen).

Air is rapidly contaminated by use; it picks up odors, exhalation products, and smoke. It is customary to replace some or all of the used air with fresh air. This is ventilation. In practice, the amount of fresh air supplied per person varies from 5 to 20 cfm, depending on the air space per occupant, their status, and the odor-removing ability of the air-conditioning system. Special equipment for odor removal will permit more recirculation. Total air supply must be sufficient to maintain desired temperature and humidity without drafts.

Circulation

Air movement or circulation is best when unnoticed; hot or cold spots are evidence of faulty distribution. Today research men are testing human subjects to find at what temperature and velocity an air stream is felt as a draft. When these data are available, one of the last sources of air-conditioning complaints will be eliminated.

So much for what air-conditioning sets out to do. How is the job done? In the typical installation, fresh air from outside is mixed with used air, returned from the conditioned space, then passed through a cleaning device. In winter months, when the air is cold and dry the equipment must add heat and moisture. First step is heating with steam or hot water coils, sometimes called tempering. Moisture is then added by passing the air through a fine spray. Further heating may be employed to raise the temper-

HOW MUCH COOLING?

Heat enters a space by conduction, by radiation from the sun, and with infiltering air or fresh supply air. Heat is generated in the space by equipment and occupants. Moisture comes in with outside air, also is given off by equipment and occupants. To maintain desired conditions, these additions must be removed; this is "cooling load". Highlight facts on each element are:

Conduction: Depends on heat-transfer rate of walls and roof (see handbooks for coefficients) and temperature difference. Don't use maximum outside temperatures; use recommended design temperatures as given by ASH&VE *Guide* and other reference books. Apply coefficients and design temperatures only to surfaces not exposed to sun.

Sun Effect: Absorption of solar radiation depends on nature of surface and location with respect to sun. Black surfaces absorb most, red brick and tile next, aluminum paint and bright metal surfaces least. Roofs absorb more than walls, east or west walls more than south. Absorption through glass can be greatly reduced by awnings, but inside blinds and shades have much less value. Capacity of building to absorb heat means a lag in effect of sun on cooled space; peak of sun load may occur after cooling system has been shut down for the day.

Outside Air: Infiltration depends on pressure differential between inside and outside. If conditioning unit supplies at least two changes of air per hr, infiltration may be neglected. Fresh air added to system must be cooled well below desired room conditions—see psychrometric chart for cooling requirements.

Equipment: Every kwhr used in conditioned space equals 3413 Btu; for every motor hp, figure 3000 to 4000 Btu. Manufactured-gas flames add about 550 Btu, per cu ft, about 50 Btu of which is represented by 0.05 lb of moisture. Values are about double for natural gas.

Occupants: Heat and moisture given off depends on temperatures, clothing, and activity. At 70 F, each person will add about 300 Btu and 0.10 lb moisture per hr, and at 90 F, about 87 Btu and 0.25 lb. Heat emission does not increase greatly with activity, but moisture does; for light clerical work increase moisture by 60%, for light factory work by 100%.

Final Pointers: Consider each item carefully—use common sense in estimating—add only those loads that occur at the same time—allow 5 to 10% for a safety factor—have cooling loads figured by a competent air-conditioning specialist if they are to be used in design.

ature and decrease the relative humidity; this reheating, if used, is mainly a control operation, giving the exact conditions desired.

In summer months, the air must be cooled and moisture removed. This dual job may be accomplished all at once, or each part may be taken care of separately. In the former case, which is most common, advantage is taken of the fact that cooling air will cause moisture to condense so that it may be removed as water. Air is passed over coils in which cold water or a refrigerant is circulating, or through a spray of chilled water. An appreciable fall of temperature results, accompanied by condensation. To get the air back to usable conditions it must be reheated, raising the temperature and lowering the relative humidity. This may be accomplished by heating coils, but it is more economical, in most cases, to mix the cold air with warm air returned from the conditioned space, the proportions being controlled to give the desired temperature and humidity. This is accomplished by a bypass duct from the return-air duct, with dampers so set that most of the used air goes to mix with the fresh air and is conditioned, but a sufficient quantity bypasses the conditioning equipment to mix with the conditioned air and heat it. This system, sometimes referred to as the "auditorium bypass", is covered by patents.

Moisture may be removed from air directly by means of adsorbent materials. Where this method is employed, cooling follows as a separate function.

After the air has been cleaned, and brought to desired temperature and humidity, it must be moved to the point of use and introduced with even distribution and without drafts. Fans provide the motive power to overcome the resistance of air ducts; dampers control quantity and direction of flow; grilles or registers introduce the air into the room to be conditioned.

Backing up this front-line equipment must be sources of heat, cold and power. Heating plants are an old story. Major source of cooling effect is refrigeration; well water, ice, and chemical cooling also have numerous applications. The electric motor is the principal source of air-conditioning power, but steam engines, steam turbines, and internal-combustion engines are particularly suited to some installations.

Pumps, piping and ducts are needed to distribute the raw materials of air conditioning. Controls regulate and coordinate the entire combination of equipment elements.

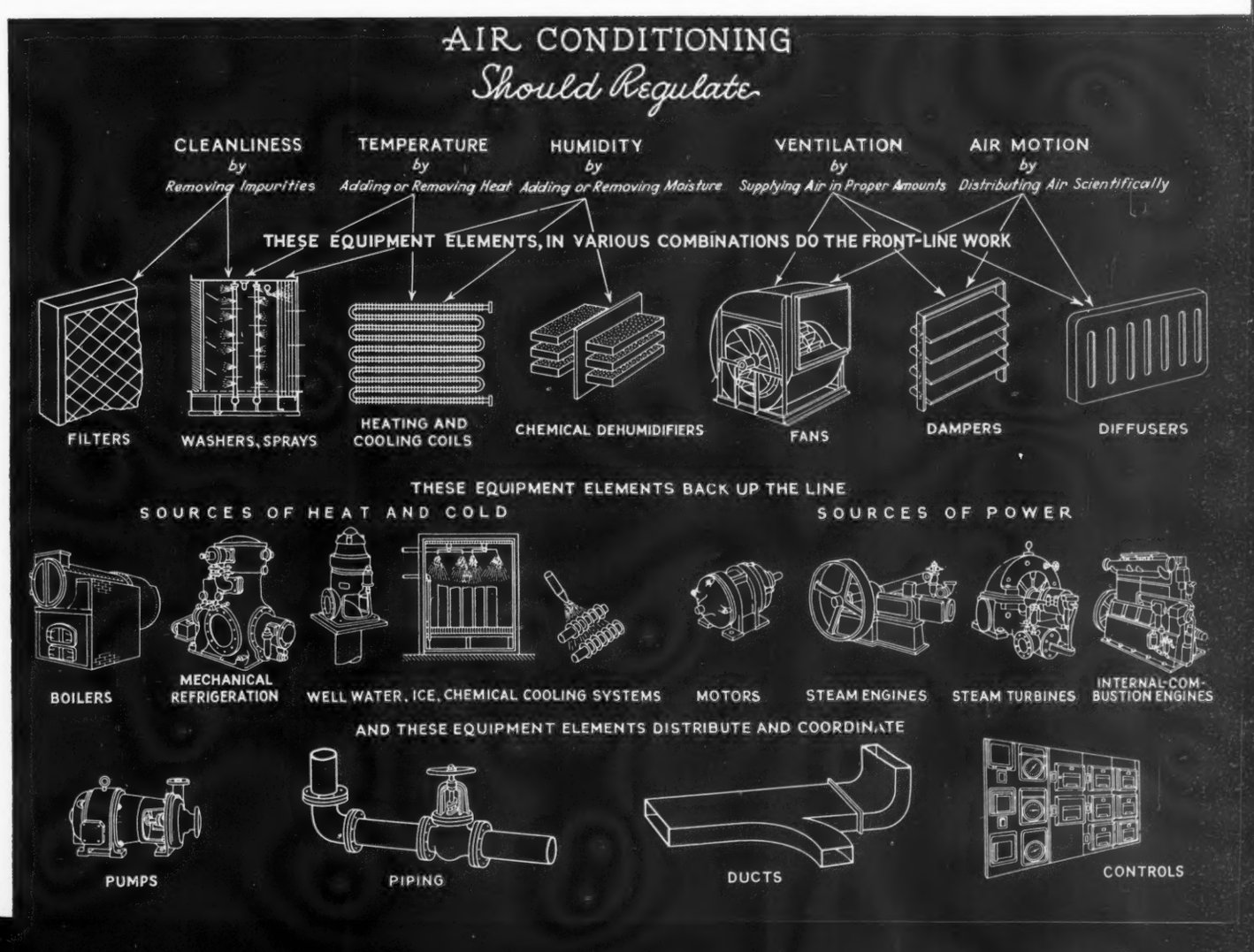
Retrospect

THE pages that follow, dealing with equipment and applications, assume that the reader is familiar with the properties of dry and moist air, as covered in *Power's* special section "Air-Conditioned Engineers", April 1936. For quick review, here is a condensed summary:

Saturated air can hold no more moisture at the given temperature. **Relative humidity** is the ratio of of actual moisture content at a given temperature, to moisture content of saturated air at the same temperature.

If unsaturated air is cooled it will become saturated, and then moisture will condense. Condensation requires the removal of a lot of heat, just as evaporation requires the addition of a lot of heat. When air is heated (away from contact with water) the actual amount of moisture does not change, but the relative humidity becomes less because at higher temperatures the air can hold more moisture.

Psychrometric charts (obtainable from equipment manufacturers) show all possible relations between air properties and will save time and trouble in air-conditioning calculations.



THE TOOLS

In air conditioning, the tools of the job are the equipment elements commercially available. Here they are, rounded up for your convenience

Filters

REMOVAL of impurities from air is the first step in conditioning; the problem is to get effective cleaning with minimum resistance to air flow. Standard devices are filters and air washers.

Dry filters clean air by straining, viscous filters by causing particles to impinge on a sticky surface. Each is made in three forms—permanent, renewable, and throwaway. For heavy duty, automatic, self-cleaning viscous filters are used.

Permanent dry filters have felt or flannel elements disposed to give a large surface in the air stream. The element can be removed from the frame for dry cleaning or can be cleaned in place with a special vacuum attachment. Dry renewable filters use cotton or paper cellulose in frames arranged so that filter sheets can be easily replaced. Similar filtering materials are used in throwaway units, but the frame is of fibre board; the entire unit is cheap enough to throw out when full.

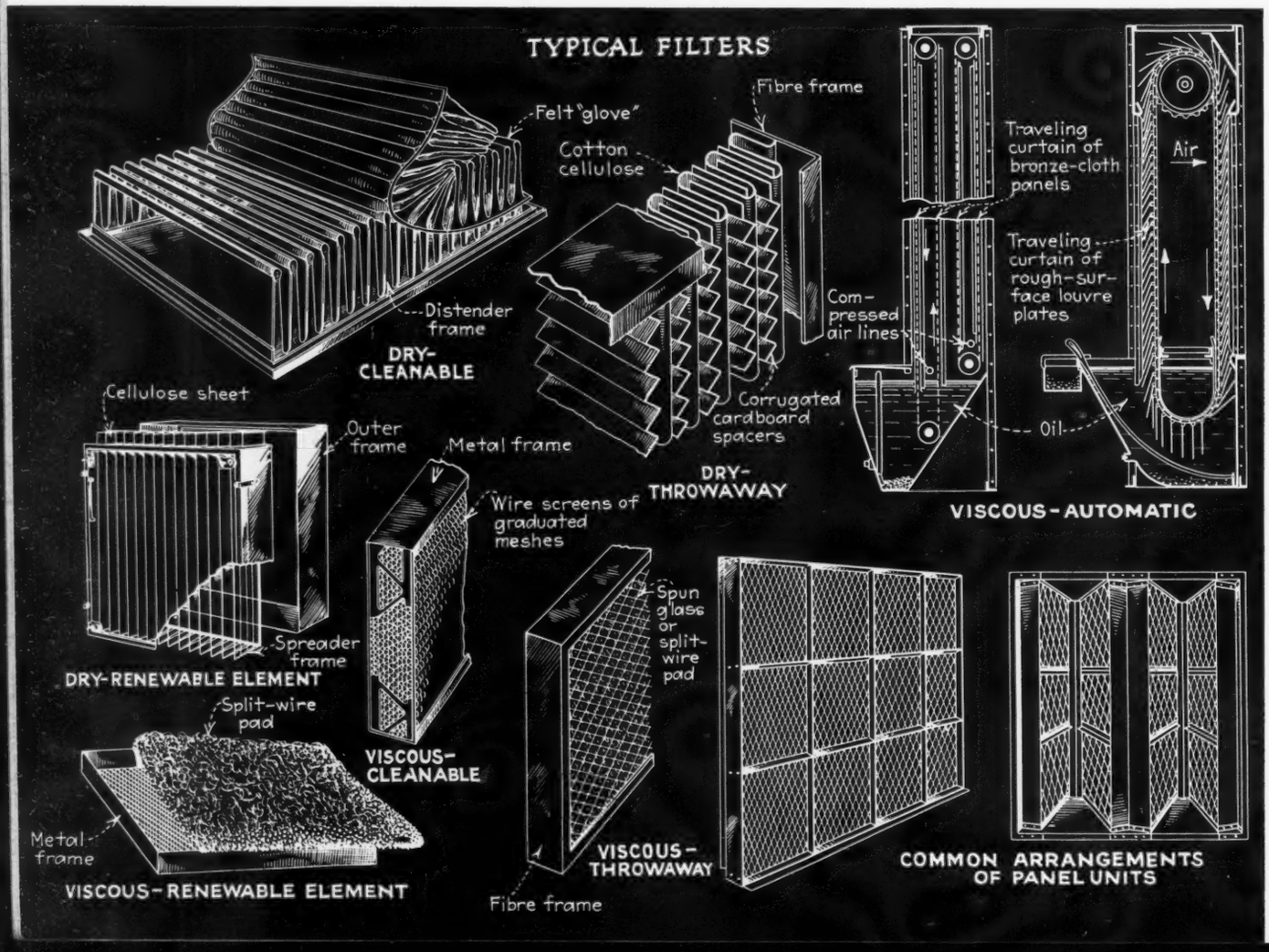
Flat and crimped wire screens, copper mesh combined with metal baffles, all coated with viscous oil, are used as filtering mediums in permanent viscous filters. Mesh is usually coarser at face of element. Filters are cleaned with steam or in an oil solvent. In the renewable type, split-wire mesh, or steel-wool elements, coated with viscous adhesive, are used in metal frames.

Throwaway units have adhesive-coated elements of spun-glass or split wire, and cheap, fibre frames.

A slowly rotating curtain of woven-wire screening or rough-surfaced louvre plates is employed in the automatic viscous filter. Immersion in the oil bath at the base cleans the screen and coats it with oil for the next trip.

Use automatic filters for large air volumes and long operating hours, viscous filters for heavy loads and coarse dusts, dry filters for lighter loads and fine dusts. Balance first cost, higher for cleanable types, against maintenance costs. Install more filtering capacity than fan capacity, allow for additional static head of filter, arrange filters for good air distribution, and don't overload them.

Air washers will clean air but are not generally as efficient as filters, particularly on fine dust and smoke. Both are sometimes used. Electrostatic precipitators are highly efficient, but high in cost, and are not yet widely applied to comfort conditioning.



Coolers and Dehumidifiers

SINCE dehumidifying can be accomplished by cooling, both jobs are usually done at once and by the same equipment. An exception to this rule is the chemical dehumidifier, which removes moisture by adsorption.

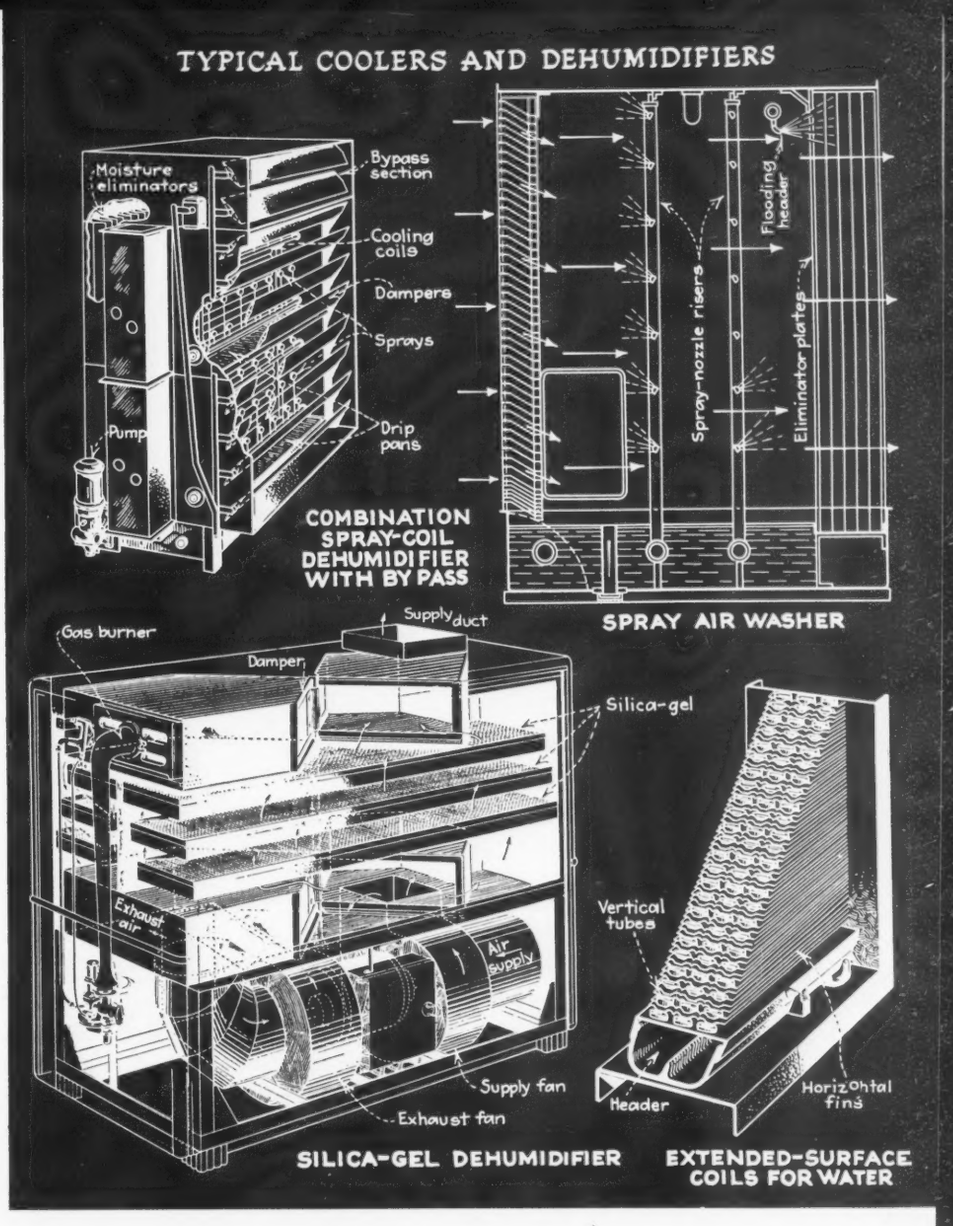
Cold sprays, cooling coils, or combinations of both are used. In the air washer, air moves through a fine mist of cold water, is nearly saturated and is cooled close to water temperature. Reheating raises temperature, but moisture content remains fixed, so relative humidity goes down.

Cooling Coils

Cooling coils are of two types, one for direct-expansion of refrigerant, the other for circulation of chilled water or brine. Direct-expansion coils, or evaporators, have extended surface for efficient transfer and consist of tubes arranged in parallel, with distributing and collecting headers for better circulation of refrigerant. Construction takes into account need for freedom from leaks. Coils for water or brine circulation have extended surface also, and are usually continuous with return bends.

Spray and coils are sometimes combined, as in the unit illustrated. This makes possible winter humidifying. Coils for cooling water may be employed for heating with hot water during the winter season, but extended-surface steam coils are more usually used for this purpose.

The silica-gel dehumidifier illustrated is typical of the chemical type. Air flows over beds of adsorbent material and moisture is removed. The dry air has a higher temperature because of the change of state. When the bed gets saturated, the air current is switched through another bed, and the moisture is driven from the adsorbent material by heating. Lithium aluminate is another solid adsorbent, or a hygroscopic solution may be used.



Fans, Dampers and Grilles

PROPELLER fans are low in cost, compact, and economical. They may be used where resistance is small and some noise is not objectionable. Most applications, however, require centrifugal fans. Forward-curved-blade fans have low tip speeds, large capacities, and are quiet. Backward-curved fans run at higher speeds and occupy more space.

Fan selection is based on efficiency and noise limitations; these depend on outlet velocity, tip speed, and static pressure. Tables of data are given in handbooks. Other factors are size and weight, drive, and first cost.

Motors are the most common fan drives. They may be direct-connected to high-speed fans, but are belted in most cases. Motor horsepower should exceed fan rating by about 20% for forward-curved fans, but can be close to rating for backward-curved fans with non-overload characteristics. Available steam at low cost, or need for exhaust steam, makes turbine or engine drive economical. Fan capacity may be controlled by speed change or, more cheaply, by throttling dampers.

Supply Outlets

Conditioned air must be introduced into a room at good velocity and low temperature to reduce the amount of air handled, and must mix thoroughly with room air so that proper distribution results.

Air-supply openings are pressed steel, wire screen, cast iron or bronze grilles with decorative faces. When equipped with deflecting vanes or louvre shutters, the unit is a diffuser or register. Capacity depends on number and size of openings and on permissible velocity. Too-high velocity means noise and drafts. Grilles are also rated on "throw," the distance over which the air will carry. Special air outlets include combined lighting fixtures and outlets, and false ceilings perforated for air diffusion.

Dampers control air quantity and direct air flow. Regulating dampers are normally of the louvre-type for close control and guiding dampers are gate-type.

Refrigeration Equipment

TAKING heat from air is one of the biggest jobs in air conditioning. The easiest way to do it is by natural means where available, direct cooling by well water, for example. Here, temperatures depend on subsurface conditions and vary even in the same locality. Well-water temperature is rarely below 55 F, but a plentiful supply at even 65 or 70 F is valuable.

Where low first cost is desired, ice is sometimes used. The simplest plan is to blow air over the ice, but it is more usual to melt ice in a tank of water or under a spray, circulating the resulting chilled water. Melting-chamber insulation minimizes heat leakage.

Because these methods have definite limitations, mechanical refrigeration is generally employed. Essential parts of a refrigeration system are: a compressor to raise the pressure of the refrigerant vapor, a condenser to cool and liquify it, and an evaporator in which the refrigerant can boil, absorbing heat from its surroundings.

Reciprocating and centrifugal compressors are of most importance; rotary displacement compressors find principal application in small room coolers. Ammonia, the traditionally standard refrigerant for reciprocating machines for its high economy, is rare in air conditioning because of its toxic hazard. Carbon dioxide is safe but relatively less economical. A newly developed refrigerant, Freon, combines acceptable thermal properties with comparative freedom from hazards. Ethyl chloride, methyl chloride, and SO_2 are used in unit room coolers where the total quantity of refrigerant is small.

Most reciprocating compressors for air-conditioning service are vertical, single-acting, multi-cylinder machines. Unit size ranges from fractional to about 1000 hp. Freon compressors require special lubrication since Freon and ordinary oil mix. Non-mixing lubricants must be used or means for separating oil must be provided.

Most economical output control is by speed change, but cost of variable-speed drive makes it little used. Throttling flow of condensing water or refrigerant reduces capacity but wastes power. Normally, capacity requirements are met by starting or stopping machines, if more than one is installed. On large machines, capacity is controlled by cutting out individual cylinders, by holding their suction valves open; by clearance pockets; or by a bypass which opens a portion of the cylinder to suction pressure.

Evaporators used to cool air directly have extended-surface tubes in which refrigerant flows, while those used to chill water are usually of shell-and-tube construction, with water in the tubes and refrigerant outside. Normal condenser equipment is also shell-and-tube, with cooling water in the tubes, refrigerant outside. Most manufacturers build self-contained units consisting of compressor, drive, condenser and control equipment, all mounted on a base, ready for connection to electric and water supply and refrigerant coils. Upper limit on these is about 50 hp; larger installations are assembled on the job from standard units.

Water and Carrene are used in centrifugal compressors, which are well adapted to handling large-volume, low - compression - range refrigerants. Resembling multi-stage centrifugal pumps, they raise pressure in small steps. Most are built as units complete with condensers, evaporators and auxiliaries, in sizes ranging from 100 to about 1000 hp. Evaporation takes place at high vacuum and a separate vacuum pump or steam-jet ejector is required to take care of leakage. In water units, the evaporator is only a shell, since the refrigerant is used as a circulating medium, evaporation of a portion chilling the remainder. Water-vapor systems are good for temperatures down to about 40 F. In Carrene units, evaporators are shell-and-tube; both water and Carrene units use shell-and-tube condensers.

Capacity control for centrifugal-compression units is most effectively and economically obtained by speed variation, but constant-speed operation is possible with suction or condensing-water throttling.

Speeds

Reciprocating compressors operate at or near motor speeds. Motor drive through V-belts is most common, usually being lowest in cost. Direct-connected synchronous motors on large machines help power-factor correction; induction motors offer low investment. Availability of steam and use for exhaust make steam-engine drive worthwhile. Where fuel prices warrant, internal - combustion - engine drive offers attractive possibilities, particularly if waste heat can be used.

The high rotative speed of centrifugal compressors makes them well suited to direct-connection with efficient high-speed turbines, giving variable speed control with attractive heat - balance possibilities. Motor drives usually require step-up gearing. Slip-ring motors may be used to control output by speed variation.

Refrigeration with water vapor may be effected by steam-jet ejectors in place of centrifugal compressors, the systems being similar in other respects. Such units are well suited where low-cost steam is available. Usual practice is to employ multiple jets, starting and stopping individual ejectors to provide output control.

In a system of cooling in which moisture is removed from air by a hygroscopic salt solution (see facing page), the latent heat (turned into sensible heat) is removed by cooling water flowing through extended-surface coils. A portion of the diluted solution is pumped to a concentrator where it is warmed in a heat exchanger by the leaving concentrated solution, which is thereby cooled. Passing to the top, the dilute solution is warmed further, and sprayed over two layers of evaporative packing with steam-heating coils between. This entire passage is counterflow to a current of outside air. Moisture is evaporated at a rate controlled by the amount of steam admitted to the heating coils.

Similar systems use solid adsorbents, used as silica-gel and lithium aluminate; in an intermittent cycle, air passes through one bed of absorbent while a second is being dried by heat, and then the flow reverses.

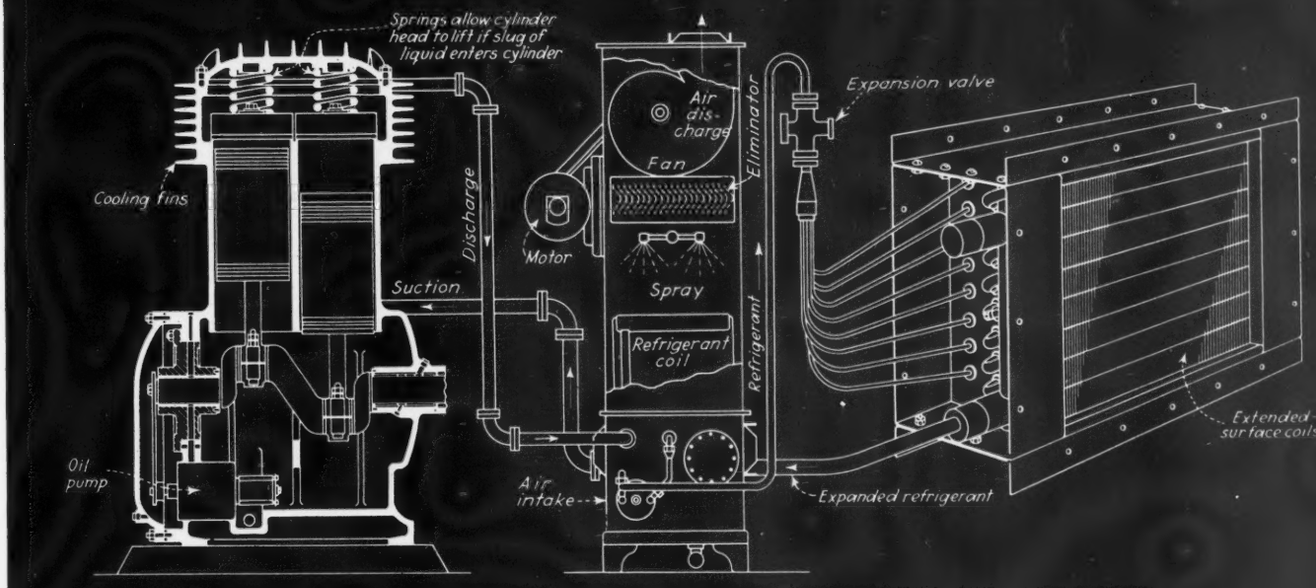
Cooling Water

All refrigeration systems require water for cooling. Cost of well and city water, sewage problems, and local ordinances against excessive water use have turned attention to water saving. Evaporative condensers will save approximately 90% by utilizing air to remove heat. Water, sprayed over the refrigerant coils, counterflow to a strong stream of air, fan-propelled, gives up heat to the air by evaporation. Only a fraction is evaporated; the remainder is recirculated by a pump. Evaporative condenser units are built for compressors up to about 100 hp.

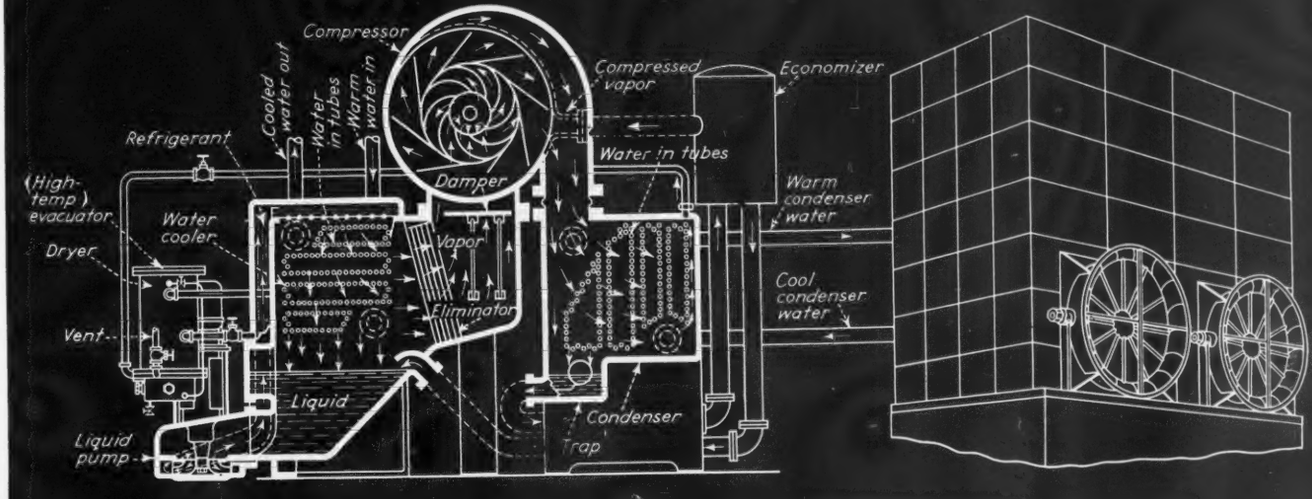
For larger installations, cooling towers take heat from water circulated in a conventional condenser. Large surfaces of water are brought into contact with an air current for evaporative cooling. Natural-draft towers are latticed, forced-draft towers have tight shells with propeller fans in the base. Occasionally spray ponds cool condenser water. Where no ground space is available, a flat roof may be used as a pond.

The illustration shows some typical units of refrigerating equipment arranged in combinations. Naturally, many other combinations are possible.

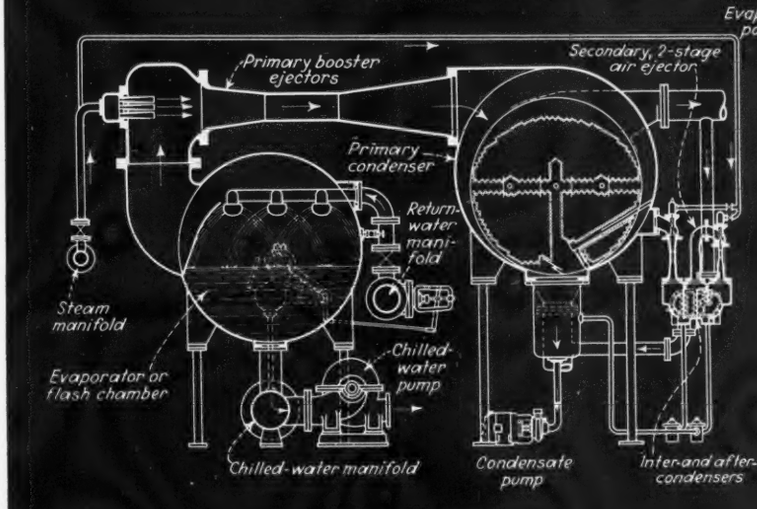
REFRIGERATION EQUIPMENT



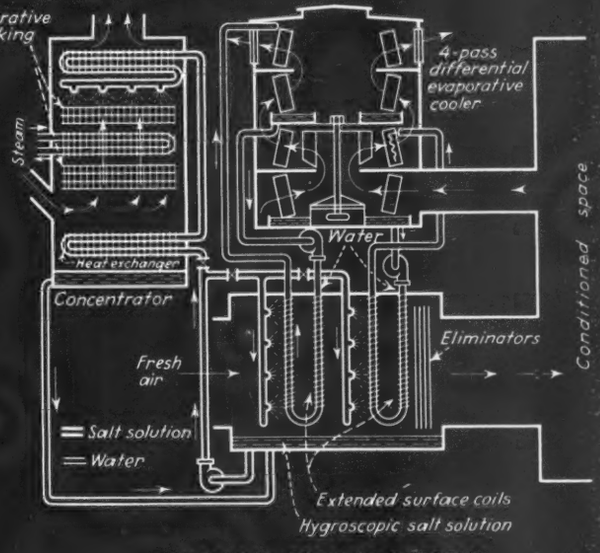
RECIPROCATING COMPRESSOR WITH EVAPORATIVE CONDENSER AND DIRECT-EXPANSION COIL



CENTRIFUGAL-COMPRESSOR-WATER-COOLER-CONDENSER UNIT AND COOLING TOWER



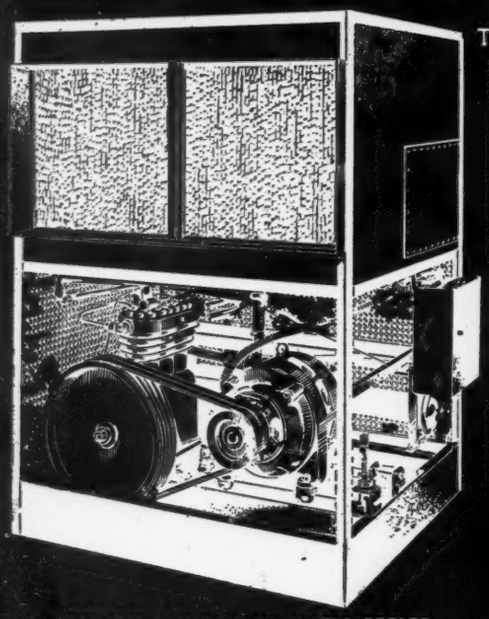
STEAM-JET UNIT



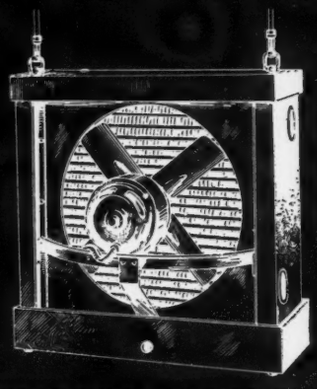
CHEMICAL COOLING SYSTEM

These are typical refrigeration-equipment elements arranged to show some possible combinations

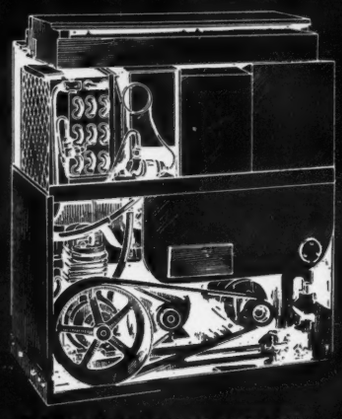
TYPICAL UNIT CONDITIONERS



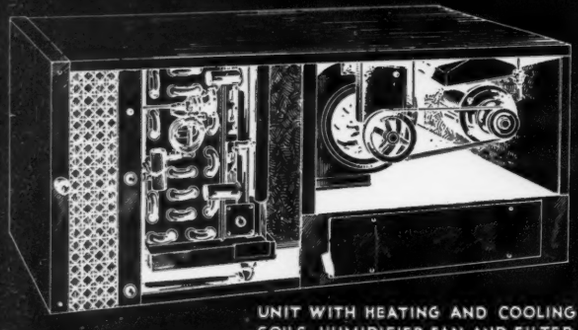
SELF-CONTAINED UNIT WITH WATER-COOLED COMPRESSOR, COOLING COILS, FAN, AND FILTER



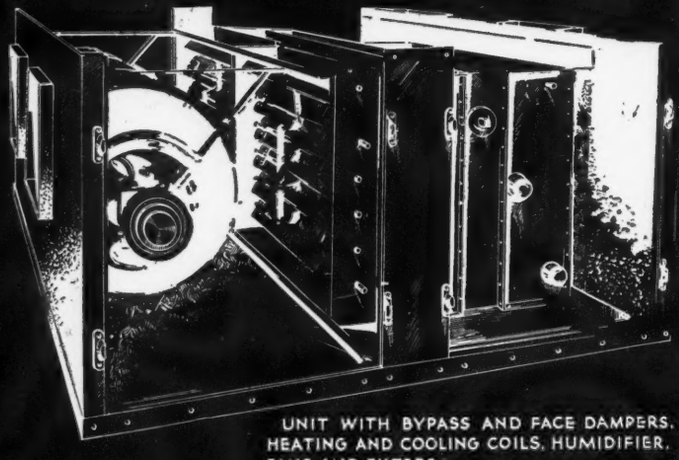
SUSPENSION UNIT WITH COILS FOR HEATING AND COOLING, AND FAN



SELF-CONTAINED UNIT WITH AIR-COOLED COMPRESSOR, COOLING COILS, FAN, AND FILTER



UNIT WITH HEATING AND COOLING COILS, HUMIDIFIER, FAN, AND FILTER



UNIT WITH BYPASS AND FACE DAMPERS, HEATING AND COOLING COILS, HUMIDIFIER, FANS, AND FILTERS

Pumps, Piping and Ducts

PUMPS for air-conditioning service should be compact, efficient and trouble-free. Most common is the centrifugal type in a combined pump-motor unit, with both elements mounted on the same shaft and base. Piping follows standard low-pressure and refrigeration practice. See special section, "Fluid Highways," in December and Mid-December *Power*.

Galvanized iron and copper-bearing steel, in gages from 18 to 26, are usual duct materials. Joints should be flat inside; stiffeners should be used for ducts more than 18 in. on the horizontal side or 24 in. on the vertical. Ducts should be short as possible, of proper area to give reasonable air velocities, and free from close bends, sudden contractions and expansions, and sharply divergent branches. Round ducts give least friction, square ducts are slightly better than rectangular forms.

Permissible velocities in air ducts are fixed by noise requirements and by friction, which increases as the square of the velocity. Recommended velocities range from 600 fpm for branch ducts and risers to 1000 fpm for horizontal ducts. Noises originating in, or transmitted to ducts may be controlled by lining the ducts with absorbent material. Canvas joints between duct and equipment, and between duct sections cut down noise transmission.

Controls and Instruments

CONTROLS maintain desired air conditions with maximum operating economy and provide for safety. Principal control elements are thermostats, sensitive to temperature; humidistats, sensitive to relative humidity; psychrostats, sensitive to changes in the difference between dry and wet bulb temperature, and pressure controllers, sensitive to pressure changes. Auxiliary elements are damper motors, control and solenoid valves, relays, and program switches. Most control impulses are not strong enough to actuate dampers and valves, so pilot systems are used with either electric or compressed-air power.

Control systems are classified as manual, semi-automatic, or automatic, and may be either 2-position or modulating. 2-position control operates without intermediate positions between extremes such as "off" and "on"; modulating control means that equipment is regulated in proportion to changes in the actuating medium.

Simplest control system is that with a single control point, suitable for small spaces and where individual conditions or preferences are not important. For larger spaces, where conditions vary from point to point, the zone system is employed, with controls in each division of the space. Individual control is less widely used, but offers the most accurate and flexible control for large buildings with numerous small spaces, particularly when individual preferences must be met.

Unit Systems

UNIT conditioners combine, in one housing, some or all of the pieces of equipment previously described. The simplest unit consists of a fan and coils for circulation of chilled water or refrigerant. A suspended cooler of this type is illustrated.

Self-contained units include refrigerating equipment; in small sizes the condenser is air-cooled; in larger sizes, water-cooled. One such unit (see illustration) is housed in a decorative casing suitable for an office. The larger unit, also illustrated, is adapted for commercial use.

Units which perform all functions except refrigeration, which is supplied from a remote point, have many applications. Two types are illustrated; each contains filters, equipment for humidifying and dehumidifying, heating and cooling, and fans. One is equipped with damper for bypassing a portion of the return air around the conditioning elements, using it to reheat the conditioned air. These units are ordinarily used with a duct system, and are really small-scale central stations.

Manufacturers of units offer a wide selection of designs, suitable for wall, floor, or ceiling mounting, in either horizontal or vertical positions. Some are equipped for cooling by circulation of chilled water, some by circulation of refrigerant. This flexibility plus the relatively low cost resulting from standardized production, makes these units extremely versatile.

Industrial Conditioning

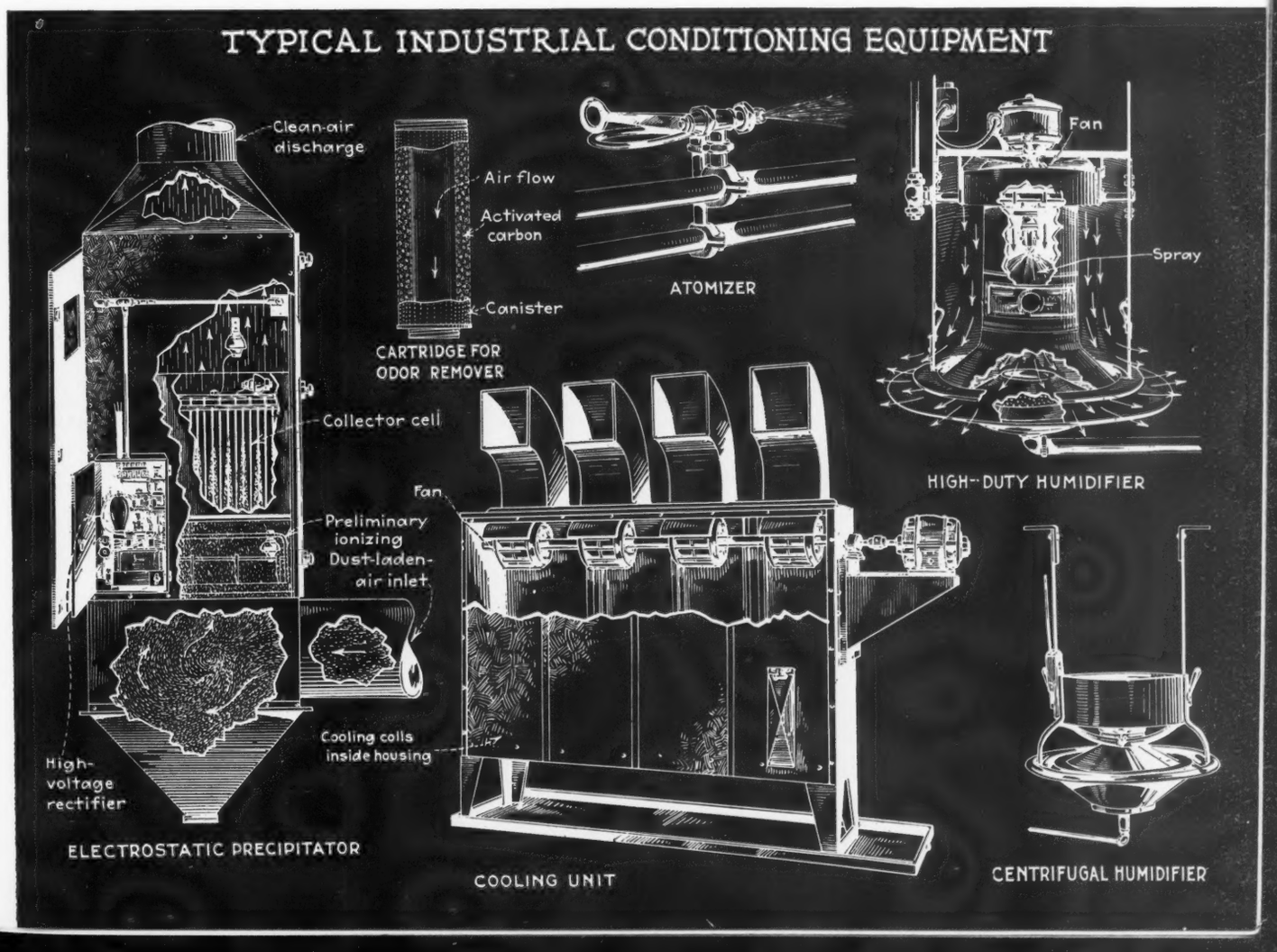
PROCESS requirements have led to development of special equipment for industrial conditioning. Typical are devices for direct humidification, simplest of which is the atomizing jet. Water is sprayed into the room by compressed air from an adjoining pipeline (see illustration). In high-duty humidifiers, a fan forces air through a casing in which a high-pressure water spray is generated. Superior mixing and distribution result. A variation gets along without the fan, depending on the aspirating effect of the nozzle. In the centrifugal or self-contained humidifier, water is thrown off a rapidly spinning disk as a fine spray into the surrounding atmosphere.

Absorption dehumidifiers using silica gel, lithium aluminate, etc, meet demands for dry air in industry, as do air washers or expansion coils in either local or central-station units.

Air conditioning has made some changes in industrial cooling practice. In modern cooling rooms, old-fashioned coils have been replaced by cooler units housing brine or direct-expansion coils and fans for air circulation. These units provide more uniform cooling at lower cost.

Dust-free air for industry is obtained by filtration, or by the newly developed electrostatic precipitator. In the latter, dust-laden air is given a high-potential electric charge and the dust particles are attracted to vanes charged with electricity of opposite polarity.

The possibility of odor-free air where needed is held out by an odor-removal device which utilizes activated carbon as the purifying element. The illustration shows a cartridge of this material; units are made by assembling a number of such cartridges (the number depending on the air flow) on plates in a housing which becomes part of the air-handling system. Standard assemblies are available for handling air flows up to about 10,000 cfm.



BUILDING A SYSTEM

Each air-conditioning job is an individual problem for which any of several solutions may be saiisfactory. Here are general rules that will help in finding the answer for certain classes of buildings

Theatres

To AVOID shock on entering and leaving, temperatures should not be too much below outdoor temperatures. With outdoor temperatures ranging from 95 F down to 70 F, inside temperatures should range down from 80 F to 72 F, with humidities from 45 to 60%. Largest part of cooling load is heat and humidity from occupants; little or no heating or humidifying is needed in winter. Removal of odors and smoke is a problem which in most cases is met by bringing in large quantities of fresh air. Recently-developed odor-removal devices may provide another solution, permitting more recirculation.

Conditioning a single space makes the central-station installation a natural choice. A major difficulty is air distribution within the auditorium, to avoid drafts and hot or cold spots. The typical theatre installation illustrated uses space above the ceiling and below the floor as plenum chambers. Good distribution is effected by introducing conditioned air through numerous diffusing outlets in the ceiling and removing air through a large number of grilles located below the seats. In most cases, the air replaced by fresh air leaves by way of the front doors, cooling the lobby and space under the marquee.

In small theatres, without balconies, air distribution from front to rear may be used, while for theatres in the 1000- to 2000-seat class, rear-to-front distribution is recommended.

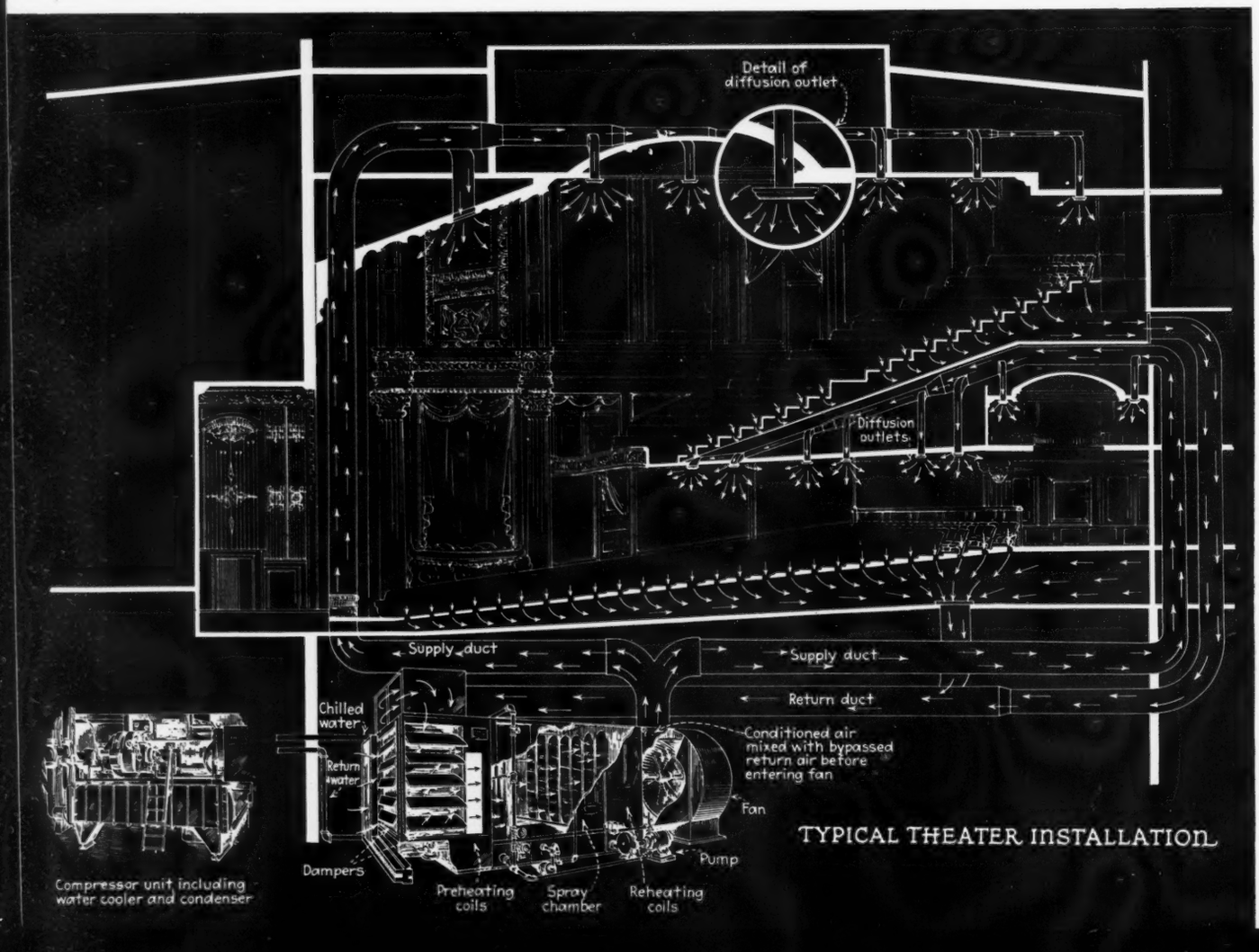
Noise control is particularly important in theatres. This means vibration-absorbing foundations for equipment, lining in the ducts, and lagging on ducts passing through noisy spaces.

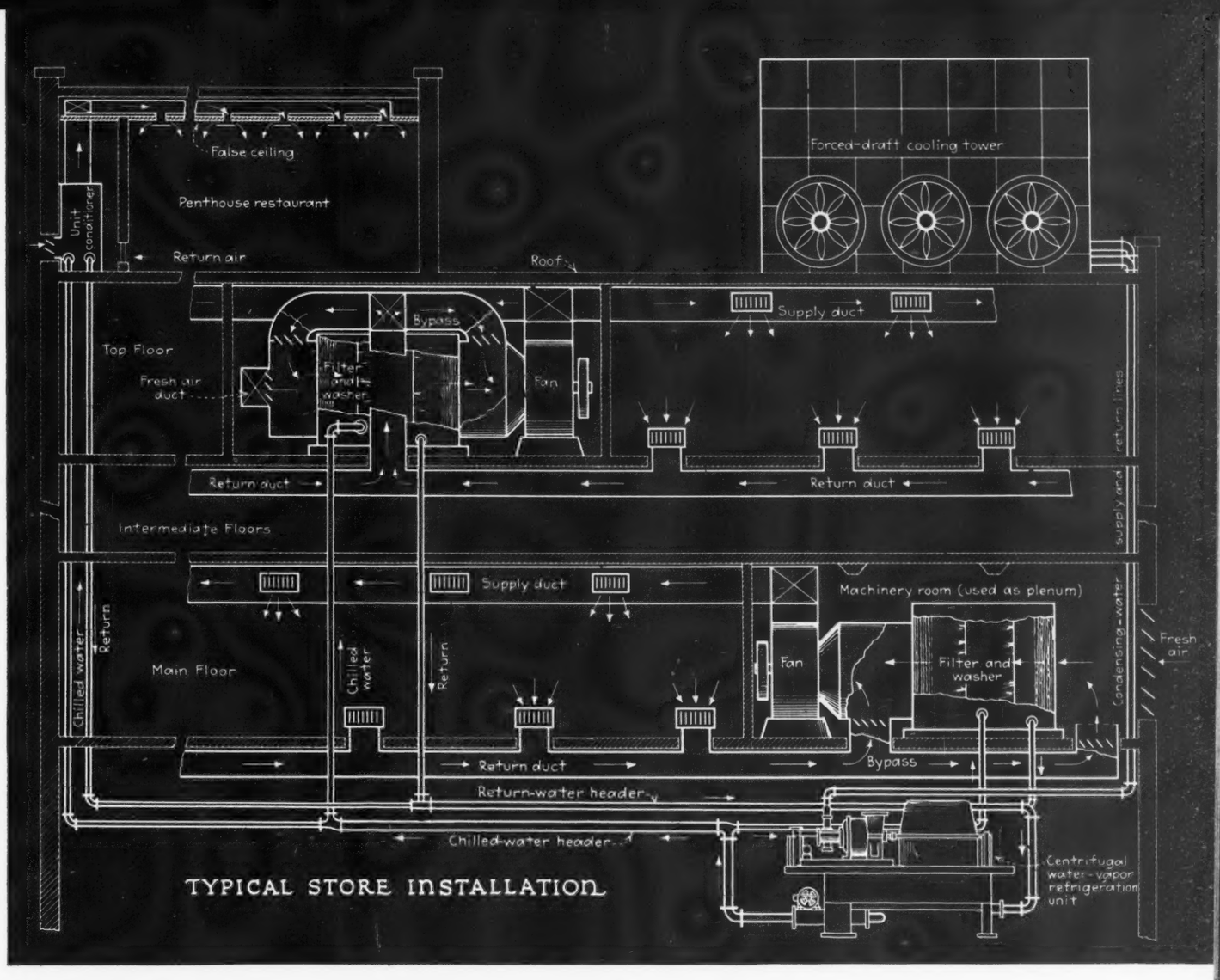
Stores

AGAIN short-time occupancy is the rule, but in stores most of the cooling load is due to lights rather than patrons or salespeople. In many cases, it is satisfactory merely to dehumidify, and reduce temperature to approximately the same as that outside.

In large, multi-story store buildings, conditioning is often confined to active departments on the lower floors and to isolated units such as restaurants and beauty parlors.

Large floor area, and relatively low





ceiling height, mean long horizontal duct runs for distribution; cooling on scattered floors means long riser ducts if a central-station system is used. The typical department-store installation illustrated shows one way of handling the problem; there are many others. All refrigeration is produced in the basement, and chilled water is circulated to various parts of the building. On the main floor, conditioning equipment is located in a machinery room used as plenum chamber. Fresh air enters through the dampers and mixes, in the room, with a portion of the recirculated air, the remainder of which is bypassed around the equipment and is used to reheat the conditioned air.

The typical intermediate floor illustrates a variation; the machinery room is located in the interior, fresh air being brought in by a duct. All air mixing is done in the housing of the conditioning apparatus. In each case, conditioned air is supplied to the floor by horizontal ducts with the necessary branches. Also illustrated is the use of unit conditioners of the large type. Such a unit is shown in the penthouse restaurant, taking in fresh air and supplying conditioned air through ceiling outlets. Similar arrangements might be used for the beauty parlor, directors' room, etc.

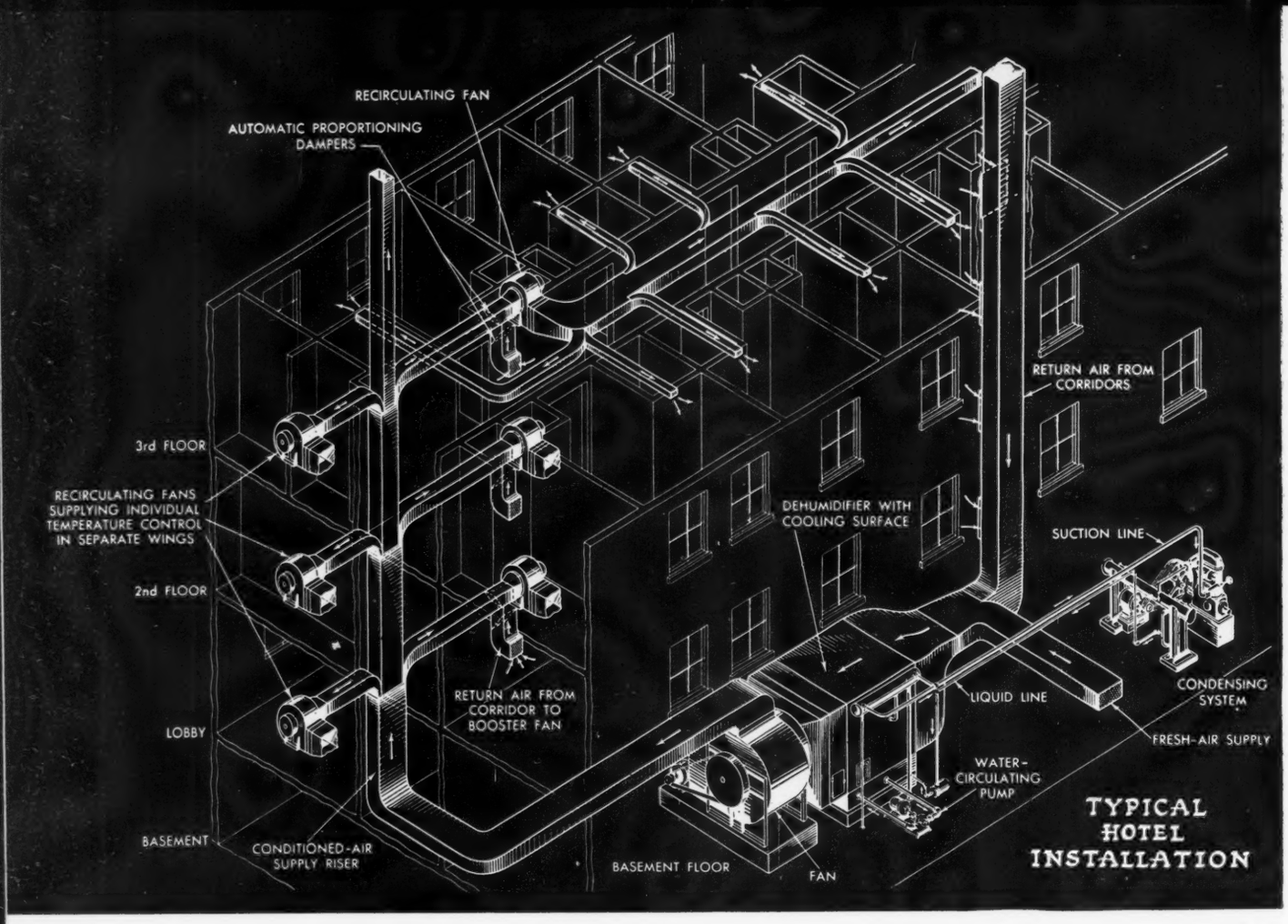
Most department-store installations are made in old buildings. Thus, winter heating is usually by radiators; the air-conditioning system is only called on for ventilation and humidifying. It also makes the installation of ducts physically difficult. Space is at a premium and appearance is important. Horizontal ducts are usually hung from the ceiling and then furred-in for concealment. In many cases, false ceilings, or other architectural details may be utilized. General noise levels in stores are high enough to make special noise elimination unnecessary. Small stores may be conditioned economically with unit conditioners, with or without ducts.

Hotels

HOTEL air conditioning presents a different variety of problems. To date, most attention has been directed to lobbies, restaurants, bars, ballrooms, and other public spaces. Again short occupancy is the rule, with fairly high human loads, and in some cases high lighting loads. Restaurants have the added problem of smoke and food odors. The poor load factor for all these rooms must be considered; low investment is indicated. As a general thing, unit conditioners, of a type dictated by the size and nature of the room, may be successfully applied, especially if no general conditioning is installed. Full-automatic control is usually not necessary.

Guest-room cooling in hotels introduces complications of cost and design, but there are numerous solutions. Illustrated is a central-station installation, with all needs supplied from refrigerating and conditioning equipment in the basement. Risers from the main fan feed local recirculating fans which act as boosters and at the same time mix the conditioned air with recirculated air before delivering it to individual rooms. Proportioning dampers at each fan permit control of air conditions in each part of each floor. This arrangement takes the place of a bypass at the main unit. Return air from the corridors is carried back to the conditioning unit by a vertical duct.

A common method is to supply rooms on a single floor from a unit



conditioner located in a service room on the same floor, and piped to the refrigerating unit in the basement. Another variation, often used where only selected rooms are conditioned, is to mount a ceiling-type unit, of small size, in a closet, with air supply through a grille over the door. Refrigerating equipment may be located on the same floor or even more remotely. Portable self-contained units with refrigeration in the cabinet give great flexibility, permitting the conditioning of any room as desired, with a minimum investment.

Many methods of installing ductwork in existing hotel buildings are available. If corridors have adequate head room, supply ducts may be hung under the ceiling and furred-in for concealment. Branch ducts furnish conditioned air to each room. Return air passes into the corridor through soundproof louvre-type grilles installed in place of a transom, and is drawn through the corridor to main grilles leading into the return riser. Where lack of headroom bars the installation of ducts in corridors, ducts may pass through the rooms if care is taken to conceal or disguise them. For quietness, duct lining is used.

Controls on conditioning units may be set to maintain desired temperatures, or a saving on refrigeration may be affected by working at a fixed differential below outside temperatures. This latter arrangement has been reported satisfactory in some cases. Where rooms are supplied by ducts, individual control of air supply is usually provided.

In large hotels, especially those generating their own power, refrigeration-equipment drive should be selected with attention to heat balance. Turbine or engine drive may utilize boiler capacity already available and may provide exhaust for water heating. Other combinations may prove desirable after the question is studied.

POINTS TO REMEMBER

WATCH city ordinances covering type of equipment that may be used, manner of installation and operation.

LOOK out for taxes on sewer outlets or water-use restrictions.

REMEMBER that the future promises rising water rates.

ALLOW for expansion if you start with partial conditioning.

CHECK the reputation of the equipment manufacturer and the local organization.

REMEMBER that competent designing engineers are worth their fee many times over.

BE SURE you understand fully what performance guarantees include.

DON'T forget that total cost is fixed charges on first cost, plus operating and maintenance costs.

Offices

OFFICE buildings have many points in common with department stores and hotels, from the air-conditioning standpoint. However, due to long-time occupancy and sedentary employment of occupants, more care must be given to determining temperature and humidity conditions for comfort, and control must be more accurate. Sun load may be an important part of the total cooling load, and means of taking care of changes during the day should be provided. Uuual practice is to divide the space into zones, conditions in each being adjusted automatically.

For large buildings, central refrigeration, with fan-rooms at strategic points (similar to that illustrated for the department store) is usually best. Duct problem is midway between that of department store and hotel. Individual control of air supply may be required in private offices, and unit conditioners meet local conditioning problems with flexibility.

411 TYPICAL AIR-CONDITIONING SYSTEMS

(50 tons* and over equivalent refrigerating capacity—installed since January 1, 1936)

*50 tons was selected as an arbitrary minimum to keep table within reasonable length

Owner and Location	Year-Round or Summer	Air-Cleaning Equipment	Dehumidifying Equipment	Humidifying	REFRIGERATION: No. of Units	REFRIGERATION: Total Cap., Tons	REFRIGERATION: Compressor Type	REFRIGERATION: Refrigerant	REFRIGERATION: Drive	REFRIGERATION: Condensing Medium	REFRIGERATION: Condensing Equipment	Transfer Equip.	Heating Method	No. of Fans	Tot. Fan Cap., 1000 cfm	Kind of Control	
20th Century-Fox Film Corp, Los Angeles	Y	AW,DF	CC	C	2	750	CE	SO_2	M	CW	CT	CFC	SC	24	1000	ASZI	THEATRES
Exp & Convention Hall, Houston, Tex	Y	AW	AW	C	2	200	RC	FR	M	CW	CT	CFC	SCR	4	150	ASI	
Lafayette Theatre, Buffalo, N.Y	Y	AW,VF	AW	C	1	170	CE	CA	M	CW	NR	CFC	SC	3	68	AI	
RKO Theatre, Highland Park, Mich	Y	DF	CC	C	3	150	RC	FR	M	WW	CT	DEC	...	3	80	PI	
Capitol Theatre, Wheeling, W.Va	Y	DF	CC	C	1	145	RC	FR	M	WW	CT	DEC / CFC	SCR	4	100	AS	
Westown Theatre, Detroit, Mich	S	VF	CC	...	3	135	RC	FR	M	CW	NR	DEC	...	1	35	PS	
Electric Theatre, Kansas City, Kan	S	....	CC	...	2	130	RC	FR	M	...	...	DEC	...	...	...	...	
Peoples Theatre, Chicago, Ill	S	....	....	...	3	130	RC	FR	M	CW	NR	....	...	...	...	...	
Roseland Ballroom, New York, N.Y	S	....	....	...	3	125	RC	FR	M	CW	NR	....	...	...	...	...	
Paramount Theatre, Texarkana, Tex	S	VF	CC	...	3	121	RC	FR	M	CW	EC	DEC	...	1	...	AS	
Stratford Theatre, Chicago, Ill	Y	DF	CC	C	2	120	RC	FR	M	CW	CT	DEC	SR	4	80	AS	
Strand & Capitol Theatres, York, Pa	Y	DF	CC	C	1	115	RC	FR	M	CW	EC	DEC	SR	2	80	AS	
Grand Theatre, Topeka, Kan	S	....	CC	...	2	115	RC	FR	M	...	...	DEC	...	...	...	...	
Alvin Theatre, Pittsburgh, Pa	Y	DF	CC	C	2	110	RC	FR	M	WW	NR	CFC / DEC	SC	2	80	PS	
Aldine Theatre, Wilmington, Del	Y	AW	AW,CC	C	1	110	RC	FR	M	CW	EC	DEC	...	3	85	AS	
Tivoli Theatre, Brooklyn, N.Y	Y	DF	CC	...	...	110	WW	H_2O	M	...	...	....	SC	1	41	MS	
Luxor Theatre, New York, N.Y	S	....	CC	...	2	103	RC	FR	M	...	...	DEC	...	...	...	...	
Symphony Theatre, Chicago, Ill	Y	VF	CC	...	3	102	RC	FR	M	CW	NR	DEC	SC	1	46	AS	
Jeffery Theatre, Chicago, Ill	Y	VF	CC	...	5	100	RC	FR	M	CW	NR	DEC	SC	1	42.5	AS	
Norside Theatre, St Louis, Mo	Y	DF	CC	...	4	100	RC	FR	M	CW	CT	DEC	SCR	1	35	PS	
Camerford Theatre, Scranton, Pa	S	VF	CC	...	3	100	RC	FR	M	CW	EC	DEC	...	1	40	AZ	
Ogden Theatre, Chicago, Ill	Y	DF	CC	C	2	100	RC	FR	M	CW	CT	DEC	SR	2	60	AS	
Midwest Theatre, Chicago, Ill	S	....	....	...	2	100	RC	FR	M	CW	NR	....	...	...	...	...	
Beyer Theatre, Excelsior Springs, Mo	S	....	CC	...	2	100	RC	FR	M	CW	CT	DEC	SC	1	...	M	
Arcade Theatre, Jacksonville, Fla	Y	VF	CC	C	4	95	RC	FR	M	CW	EC	DEC	SC	2	30	AZ	
Brighton Theatre, Chicago, Ill	S	....	....	...	2	90	RC	FR	M	CW	NR	....	...	...	...	...	
Colonial Theatre, Pittsburgh, Pa	S	....	CC	...	1	90	RC	FR	M	...	...	DEC	...	...	...	...	
Liberty Theatre, Sedalia, Mo	S	....	CC	...	1	90	RC	FR	M	...	...	DEC	...	...	...	...	
Illinois Theatre, Centralia, Ill	S	....	CC	...	1	90	RC	FR	M	...	...	DEC	...	...	...	...	
Kennedy Theatre, Kirksville, Mo	S	....	CC	...	1	90	RC	FR	M	...	...	DEC	...	...	...	...	
Saenger Theatre, Biloxi, Miss	Y	VF	CC	C	2	87.5	RC	FR	M	CW	EC	DEC	WC	1	...	AS	
Rhodes Theatre, Chicago, Ill	Y	VF	CC	...	2	86	RC	FR	M	CW	NR	DEC	SC	1	35	AS	
Strand Theatre, Port Arthur, Tex	Y	DF	CC	C	2	85	RC	FR	M	WW	NR	DEC	SCR	3	50	AS	
Palmer Park Theatre, Highland Park, Mich	S	....	....	...	2	81	RC	FR	M	CW	NR	....	...	...	...	...	
Washington Theatre, Detroit, Mich	S	VF	CC	...	2	80	RC	FR	M	CW	EC	DEC	...	1	24	PS	
Liberty Theatre, Pittsburgh, Pa	S	VF	CC	...	2	80	RC	FR	M	CW	EC	DEC	...	1	28	AS	
Gadsden Theatre, Gadsden, Ala	S	VF	CC	...	2	80	RC	FR	M	CW	CT	DEC	SC	1	40	AS	
15th & Lewis Theatre, Tulsa, Okla	Y	DF	CC	C	2	80	RC	FR	M	CW	EC	DEC	SC	1	30	AS	
Colonial Theatre, New York, N.Y	S	....	CC	...	2	80	RC	FR	M	...	...	DEC	...	...	...	...	
Paramount Theatre, Monroe, La	S	VF	CC	...	2	79	RC	FR	M	CW	EC	DEC	...	1	...	AS	
Stadium Theatre, Evanston, Ill	Y	VF	CC	...	2	78	RC	FR	M	CW	NR	DEC	SC	1	32.5	PS	
Tower Theatre, Oklahoma City, Okla	Y	DF	CC	C	3	75	RC	FR	M	CW	EC	DEC	SC	1	30	AS	
Shea Theatre, Cambridge, Ohio	Y	VF	CC	...	3	75	RC	FR	M	WW	NR	DEC	SC	1	21	AS	
Paramount Theatre, Gulfport, Miss	S	VF	CC	...	3	73	RC	FR	M	CW	EC	DEC	...	1	...	AS	
Paramount Theatre, Alexandria, La	S	VF	CC	...	3	70.5	RC	FR	M	CW	EC	DEC	...	1	...	AS	
Beacham Theatre, Orlando, Fla	S	VF	CC	...	2	70	RC	FR	M	CW	EC	DEC	SC	1	28	AS	
Florida Theatre, W. Palm Beach, Fla	S	VF	CC	...	2	70	RC	FR	M	CW	EC	DEC	SC	1	28	AS	
Cosmos Theatre, Chicago, Ill	Y	DF	CC	C	2	65	RC	FR	M	CW	CT	DEC	SR	3	40	AS	
Isis Theatre, Fort Worth, Tex	S	DF	CC	...	3	63	RC	FR	M	CW	CT	DEC	...	1	25	AS	
Haymarket Theatre, Chicago, Ill	S	DF	CC	...	1	62	RC	FR	M	CW	NR	DEC	SC	1	...	AS	
Regent Theatre, Wellington, Kan	S	DF	CC	...	1	62	RC	FR	M	WW	EC	DEC	...	1	...	MS	
Granada Theatre, Lawrence, Kan	S	AW	CC	...	1	62	RC	FR	M	CW	CT	DEC	SC	1	30	...	
Strand Theatre, Memphis, Tenn	Y	VF	CC	C	3	62	RC	FR	M	CW	EC	DEC	SC	1	...	AS	
Strand Theatre, Hays, Kan	S	....	CC	...	1	62	RC	FR	M	CW	NR	DEC	...	1	20	MS	
Saenger Theatre, Vicksburg, Miss	S	VF	CC	...	3	60.5	RC	FR	M	CW	EC	DEC	...	1	...	AS	
H B Yost, Harrisburg, Pa	Y	DF	CC	C	1	60	WW / RC	H_2O / FR	... / M	WW / CW	NR / NR	CFC / DEC	WC	1	15	AS	
Adams Theatre, Detroit, Mich	S	VF	CC	...	2	60	RC	FR	M	WW	NR	DEC	...	1	40	PS	
Rialto Theatre, Atlanta, Ga	Y	VF	CC	...	3	60	RC	FR	M	CW	CT	DEC	SC	1	22	AS	
Bardayon Theatre, Poughkeepsie, N.Y	S	VF	CC	...	2	60	RC	FR	M	CW	EC	DEC	...	1	28	AS	
Carmen Theatre, Philadelphia, Pa	Y	DF	CC	C	1	60	RC	FR	M	CW	EC	DEC	SCR	3	40	PS	
Sheridan Theatre, Washington, D.C	Y	DF	CC	C	1	60	RC	FR	M	CW	EC	DEC	SCR	3	40	PS	
Tivoli Theatre, Michigan City, Ind	S	AW,VF	AW,CC	...	2	60	WW / RC	H_2O / FR	... / M	WW / CW	NR / NR	DEC	...	2	24	PS	
Christian Science Church, Baltimore, Md	S	VF	CC	...	2	60	RC	FR	M	CW	NR	DEC	...	1	16	AS	
Times Theatre, Chicago, Ill	Y	VF	CC	...	2	60	RC	FR	M	CW	NR	DEC	...	1	35	AS	
Liberty Theatre, Covington, Ky	Y	AW	AW	C	1	60	RC	FR	M	WW	CT	DEC	...	3	35	PI	
Majestic Theatre, Shreveport, La	S	VF	CC	...	3	57.5	RC	FR	M	CW	EC	DEC	...	1	...	AS	
Frolic Theatre, Chicago, Ill	Y	DF	CC	C	2	55	RC	FR	M	CW	CT	DEC	SR	3	40	AS	
Hamilton Theatre, Chicago, Ill	Y	DF	CC	C	2	55	RC	FR	M	CW	CT	DEC	SR	2	35	AS	
Rivoli Theatre, Long Beach, Calif	Y	VF	CC	...	2	55	RC	FR	M	CW	SP	DEC	...	1	25	AS	
State Theatre, Hanover, Pa	Y	DF	CC	C	1	53	RC	FR	M	CW	EC	DEC	SR	2	40	AS	
Paramount Theatre, Hot Springs, Ark	S	VF	CC	...	3	52	RC	FR	M	CW	EC	DEC	...	1	...	AS	
Rex Theatre, Shreveport, La	Y	VF	CC	C	2	50.5	RC	FR	M	CW	EC	DEC	WC	1	...	AS	
Park Hall Theatre, Cincinnati, Ohio	S	AW	AW,CC	...	1	50	RC	FR	M	WW	NR	DEC	...	1	14	AS	
Rhodes-Center Theatre, Atlanta, Ga	S	VF	CC	...	1	50	RC	FR	M	CW	CT	DEC	SC	1	18	AS	
5th Ave Theatre, Nashville, Tenn	S	VF	CC	...	2	50	RC	FR	M	CW	CT	DEC	SC	1	25	AS	
Teche Lines Inc, New Orleans, La	Y	VF	CC	C	2	50	RC	FR	M	CW	EC	DEC	SC	1	...	PS	
Princess Theatre, Hopkinsville, Ky	S	VF	CC	...	2	50	RC	FR	M	CW	CT	DEC	SC	1	20	AS	
Tivoli Theatre, Fort Worth, Tex	Y	DF	CC	C	3	50	RC	FR	M	CW	EC	DEC	SC	3	30	PI	
Princeton Playhouse, Princeton, N.J	S	....	....	...	1	50	RC	FR	M	CW	NR	....	...	...	...	...	
Sevier Theatre, Johnson City, Tenn	S	....	....	...	1	50	RC	FR	M	CW	EC	DEL	...	...	...	...	
Gimbel Bros, Philadelphia, Pa	Y	AW,VF	AW,CC	C	2	1200	CE	CA	M	CW	CT	CFC	SC	17	506	AZ	STORES
Joseph Horne, Pittsburgh, Pa	Y	AW,VF	AW,CC	C	2	990	CE	CA	M	WW	NR	CFC	SC	25	411	AZ	
Goldsmith's, Memphis, Tenn	Y	AW	AW,CC	C	2	770	WW / RC	H_2O / FR	M	WW	CT	CFC	SR	8	500	PZ	
Younkers Bros, Inc, Des Moines, Iowa	Y	AW	AW	C	1	650	CE	CA	M	WW	NR	CFC	SC	21	258	AZ	
Sears Roebuck & Co, Kansas City, Mo	S	VF	CC	C	2	630	RC	NH_3	SE	CW	CT	CFC	...	...	...	AZ	
Gimbel Bros, Pittsburgh, Pa	Y	AW	AW	C	2	600	RC	FR	M	WW	CT	CFC	SCR	5	500	PZ	
Davison-Paxon Co, Atlanta, Ga	Y	AW	AW	C	3	550	RC	FR	M	WW	NR	CFC	SCR	6	203	PZ	
Gold & Co, Lincoln, Neb	Y	VF	SG	...	...	540	WW	H_2O	...	...	...	CFC	...	...	...	AZ	

A — absorption system
AI — automatic individ. control
AS — automatic single control
AZ — automatic zone control
AVF — automatic viscous filter
AW — air washer
BS — brine spray
C — central dehumidification
CA — Carrene
CC — cooling coil
CE — centrifugal compressor
CFC — chilled fluid — central
CFL — chilled fluid — local
CFCL — both CFL & CFC
CO_2 — carbon dioxide
CT — cooling tower
CW — city water
D — direct humidifying (in room)
DE — diesel engine
DF — dry filter
DEC — direct expansion — central
DEL — direct expansion — local
DECL — both DEC & DEL
EC — evaporative condenser
FR — Freon
GE — gas engine
H_2O — water
M — motor
MI — manual individual control
MS — manual single control
MZ — manual zone control
NH_3 — ammonia
NR — no recirculation
PI — semi-auto. individ. control
PS — semi-auto. single control
PZ — semi-auto. zone control
RC — reciprocating compressor
RO — rotary compressor
S — summer cooling only
SC — steam coils in duct–central
SCL — both steam coils & radiation
SE — steam engine
SG — silica gel
SJ — steam-jet compressor
SL — steam radiation — local
SO_2 — sulphur dioxide
SP — spray pond
ST — steam turbine
SW — sea water
VF — viscous filter
WC — hot-water coils in duct
WL — hot-water radiation
WS — water spray
WW — well water
Y — year-round conditioning

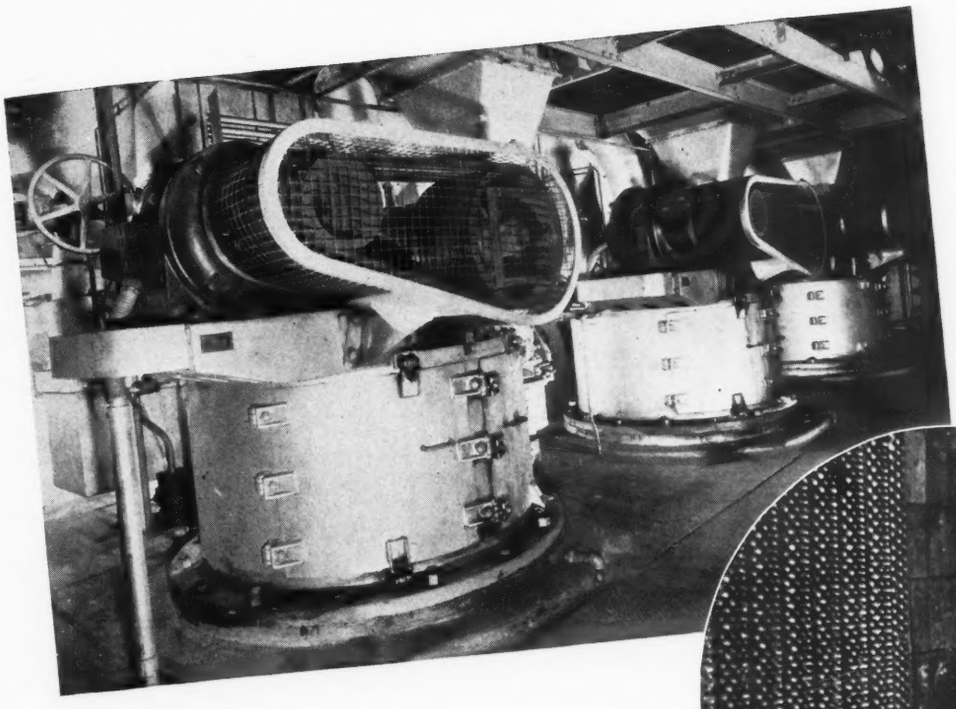
STORES

Owner and Location	Year-Round or Summer	Air-Cleaning Equipment	Dehumidifying Equipment	Humidifying	REFRIGERATION: No. of Units	REFRIGERATION: Total Cap., Tons	REFRIGERATION: Compressor Type	REFRIGERATION: Refrigerant	REFRIGERATION: Drive	REFRIGERATION: Conden. Medium	REFRIGERATION: Conden. Equipment	Transfer Equip.	Heating Method	No. of Fans	Tot. Fan Cap., 1000 cfm	Kind of Control
F Loeser & Co, Brooklyn, N.Y.	Y	AVF	CC,SG	C	2	600	RC / WW	FR / H_2O	M	CW	CT	CFCL	SC	22	140	AZ
M Rich & Bros Co, Atlanta, Ga.	Y	DF,AW	AW	C	2	428	RC	FR	M	CW	CT	CFC / DEC	SC	14	137	AZ
John Shillito Co, Cincinnati, Ohio	Y	AW	AW,CC	G	2	400	WW / RC	H_2O / FR	M	CW	CT	DEL	SR	30	300	PZI
Wolfe & Dessauer, Ft. Wayne, Ind.	Y	VF	CC	C	8	400	RC	FR	M	CW	CT	CFC	...	14	172	AZ
H & S Pogue, Cincinnati, Ohio	Y	VF	CC	C	1	400	CE	CA	ST	CW / WW	CT / NR	CFC	SC	6	130	ASZ
Sears Roebuck & Co, Memphis, Tenn.	S	....	CC	...	2	400	RC	NH_3	SE	...	...	CFC	...	...	...	...
Kline's Inc, Kansas City, Kan.	Y	DF	CC	C	2	370	RC	FR	M	CW	CT	CFL	SR	9	200	PZI
Mandel Bros Inc, Chicago, Ill.	Y	VF	CC	C	1	350	CE	CA	M	CW	NR	CFCL	SC	4	60	ASZ
Mabley & Carew Co, Cincinnati, Ohio	Y	AW,VF	AW,CC	C	2	340	CE	CA	M	CW	CT	CFC	SC	11	144	ASZ
Lowenstein's Store, Memphis, Tenn.	Y	AW	AW	C	3	330	RC	FR	M	WW	CT	CFC	SCR	7	200	PZ
Miller Bros, Knoxville, Tenn.	Y	AW,VF	AW	C	2	325	RC	FR	M	CW	CT	CFC	SC	4	100	AZ
Louis Pizitz, Birmingham, Ala.	Y	AW	AW	C	2	317	RC	FR	M	CW	CT	CFC	SR	5	200	PZ
Josker Bros, San Antonio, Tex.	S	AW,DF	CC	...	1	316	CE	CA	M	CW	CT	CFC	...	18	120	AZ
Miller Bros, Chattanooga, Tenn.	Y	AW	AW	C	2	300	RC	FR	M	WW	CT	CFC	SCR	5	220	PZ
John Gerber Co, Memphis, Tenn.	Y	AW	AW,CC	C	2	270	RC	FR	M	WW	CT	CFCL	SCR	7	200	PZ
F W Woolworth, New York, N.Y.	Y	AW	AW	C	3	265	RC	FR	M	WW	CT	DEC	SCR	...	...	PZ
Sears Roebuck & Co, Dallas, Tex.	Y	....	CC	...	2	250	RC	NH_3	GE	CW	...	CFC	WC	...	...	...
Marshall Field Co, Oak Park, Ill.	Y	AVF	CC	C	1	250	CE	CA	M	CW	CT	CFC	SC	10	104	AS
Montgomery-Ward Co, Sacramento, Cal.	S	....	CC	...	2	225	RC	NH_3	SE	...	...	CFC	...	...	...	...
S H Kress & Co, Birmingham, Ala.	Y	AW,VF	AW,CC	C	6	222	RC	FR	M	CW	EC	DEC	SC	7	128	AZ
S S Kresge, Chicago, Ill.	Y	VF	CC	C	1	220	CE	CA	M	CW	NR	CFC	SC	2	62	AZ
John Wanamaker, New York, N.Y.	Y	DF	AW	C	2	215	RC	FR	M	CW	CT	CFC	...	2	...	PZ
Thalhimer Bros, Richmond, Va.	S	....	....	...	1	214	RC	FR	M	CW	NR	CFL	...	...	...	...
F W Woolworth, Jamaica, N.Y.	Y	AW	AW,CC	C	2	206	RC	FR	M	WW	NR	CFC / DEC	SCR	4	160	PZ
Lansburgh Bros, Washington, D.C.	Y	AW	AW	C	4	200	RC	FR	M	CW	EC	CFC	SC	1	109	AZ
Kaufman's Store, Pittsburgh, Pa.	Y	AW	AW	C	4	200	RC	FR	M	CW	EC	DEC	SR	2	100	PZI
S H Kress & Co, Miami, Fla.	Y	AW	AW,CC	C	8	200	RC	FR	M	CW	CT	DECL	SC	...	...	PZ
Namm Dept Store, Brooklyn, N.Y.	S	AVF	CC	...	1	200	RC	FR	DE	WW	NR	CFL	...	8	100	AZ
Gus Blass Co, Needlerock, Ark.	Y	DF	CC	C	1	188	RC	FR	M	WW	CT	CFCL	...	...	...	PZ
Sears Roebuck & Co, St. Louis, Mo.	S	AVF	CC	...	1	180	SJ	H_2O	...	CW	CT	CFC	...	3	75	PZ
Sears Roebuck & Co, Nashville, Tenn.	Y	DF	CC	C	2	180	RC	FR	M	CW	SP	CFCL	...	6	150	PZ
S H Kress & Co, Houston, Tex.	S	AW,VF	AW,CC	C	5	178	RC	FR	M	CW	EC	DEC	...	3	50	AI
McCrory Store, Baltimore, Md.	S	DF	CC	C	2	175	RC	NH_3	M	CW	CT	CFC	SC	2	150	...
McCrory Store, Philadelphia, Pa.	S	DF	CC	C	2	175	RC	NH_3	M	CW	CT	CFC	SC	2	150	...
S H Kress & Co, Atlanta, Ga.	Y	DF	CC	...	6	173	RC	FR	M	CW	EC	DEC	SC	6	59	AI
F W Woolworth, Minneapolis, Minn.	Y	AW	AW	C	2	169	RC	FR	M	WW	NR	DEC	SCR	3	120	PZ
Marks Isaacs Co, New Orleans, La.	S	VF	CC	...	4	160	RC	FR	M	CW	EC	DECL	...	4	48	PI
F W Woolworth, Los Angeles, Cal.	Y	AW	AW	C	2	157	RC	FR	M	CW	EC	DEC	SCR	3	120	AZ
Boston Store, Wichita, Kans.	S	....	....	...	1	150	CE	H_2O	ST	WW	NR	....	...	...	...	...
Sears Roebuck & Co, Indianapolis, Ind.	Y	DF	CC	C	4	150	RC	FR	M	CW	CT	DECL	SCR	4	90	PZ
S H George & Sons, Knoxville, Tenn.	S	VF	CC	...	3	150	RC	FR	M	CW	CT	CFCL	SR	16	64	AZ
Brockelman Bros, Worcester, Mass.	Y	DF	....	C	1	145	RC	FR	M	CW	EC	DECL	SC	3	37	PZ
H P Wasson, Indianapolis, Ind.	Y	DF	CC	C	1	145	CE	CA	M	CW	NR	CFL	SR	7	54	AZ
Sears Roebuck & Co, Tulsa, Okla.	S	....	CC	...	2	145	RC	FR	M	...	...	DEC	...	...	...	...
S H Kress & Co, Salt Lake City, Utah	S	AW,VF	AW,CC	C	3	143	RC	FR	M	CW	EC	DEC	...	2	74	AI
F W Woolworth, Milwaukee, Wis.	Y	DF	CC	C	2	140	RC	FR	M	WW	NR	DEC	SCR	3	80	PZ
Sakowitz Bros, Houston, Tex.	Y	DF	CC	...	1	140	CE	CA	M	CW	CT	CFCL	...	5	43	AZ
Federal Dept Store, Detroit, Mich.	S	VF	CC	...	3	135	RC	FR	M	CW	NR	DEC	...	1	35	PS
Brown Shoe Co, St. Louis, Mo.	Y	AW	AW,CC	C	1	130	RC	FR	M	CW	CT	DEC	SCR	2	100	PZI
Alexander's Store, New York, N.Y.	S	VF	CC	...	3	130	RC	FR	M	CW	NR	CFC	...	3	40	AZ
F Loeser & Co, Garden City, N.Y.	Y	DF	CC	C	1	130	RC	FR	M	WW	CT	DEC	...	...	...	PZ
F W Woolworth, Baltimore, Md.	Y	AW	AW	C	1	128	RC	FR	M	WW	EC	CFC	SCR	2	60	PZ
G C Murphy Co, Washington, D.C.	Y	AW	AW	C	1	125	RC	FR	M	CW	CT	CFCL	SR	...	...	PZ
F W Woolworth, Wilkes Barre, Pa.	Y	AW	AW	C	2	125	RC	FR	M	CW	EC	DEC	SCR	3	100	PZ
Loveman's Store, Chattanooga, Tenn.	Y	AW	AW,CC	C	1	122	RC	FR	M	CW	CT	DEC	...	...	...	PZ
F W Woolworth, Boston, Mass.	Y	AW	AW	C	1	121	RC	FR	M	CW	EC	CFC	SCR	4	90	PZ
B F DeWees, Philadelphia, Pa.	Y	VF	CC	C	3	120	RC	FR	M	CW	CT	DEC	SC	6	51	AZ
McCrory Store, Atlanta, Ga.	Y	VF	CC	...	3	120	RC	FR	M	CW	CT	DEC	...	2	38	AS
Neisner Bros, Inc, Utica, N.Y.	Y	DF	CC	C	3	120	RC	FR	M	CW	NR	DECL	SC	6	28	AI
Sears Roebuck & Co, Louisville, Ky.	Y	DF	CC	C	2	120	RC	FR	M	WW	CT	DEC	SCR	5	85	AZ
F W Woolworth, Harrisburg, Pa.	Y	AW	AW	C	2	120	RC	FR	M	CW	EC	DEC	SCR	4	100	PZ
F W Woolworth, St. Louis, Mo.	Y	AW	AW	C	1	116	RC	FR	M	WW	NR	CFC	SCR	4	90	PZ
S H Kress & Co, Memphis, Tenn.	S	DF	CC	...	2	116	WW / RC	H_2O / FR	M	WW	NR	DEC	...	1	29	AS
J J Newberry Co, Milwaukee, Wis.	Y	DF	CC	...	2	115	RC	FR	M	WW	NR	DEC	...	...	...	PZ
F W Woolworth, Johnstown, Pa.	Y	AW	AW	C	1	112	RC	FR	M	CW	CT	DEC	...	1	...	PZ
W T Grant Co, Tampa, Fla.	Y	VF	CC	C	2	112	RC	FR	M	CW	EC	DEC	...	...	37	AI
G C Murphy Co, Washington, D.C.	Y	DF	CC	C	1	110	RC	FR	M	CW	CT	DEC	SCR	2	80	AZ
Maas Bros, Tampa, Fla.	Y	AW	AW,CC	C	1	110	RC	FR	M	WW	NR	CFC	SC	2	60	PZ
F W Woolworth, Omaha, Neb.	Y	AW	AW	C	1	110	RC	FR	M	WW	NR	CFC	SCR	2	50	PZ
F W Woolworth, Brooklyn, N.Y.	Y	AW	AW,CC	C	1	106	RC	FR	M	WW	NR	CFC	SCR	3	80	PZ
F W Woolworth, Pittsburgh, Pa.	Y	AW	AW,CC	C	1	106	RC	FR	M	WW	NR	DEC	SCR	2	80	PZ
Katz Drug Co, Okla. City, Okla.	S	....	CC	...	2	103	RC	FR	M	...	...	DEC	...	...	...	...
G C Murphy Co, Pittsburgh, Pa.	Y	DF	CC	C	1	103	RC	NH_3	M	CW	CT	CFC	SR	3	50	PZI
Myers Store, Greensboro, N.C.	Y	DF	CC	C	2	100	RC	FR	M	WW	EC	DEC	SCR	4	80	PZ
F W Woolworth, Des Moines, Iowa	Y	AW	AW,CC	C	1	100	RC	FR	M	CW	EC	DEC	SCR	2	70	PZ
F W Woolworth, Fort Worth, Tex.	Y	AW	AW	C	1	95	RC	FR	M	WW	NR	CFC	SCR	4	80	PZ
F W Woolworth, Scranton, Pa.	Y	AW	AW	C	1	95	RC	FR	M	WW	NR	CFC	SCR	2	60	PZ
F W Woolworth, Dallas, Tex.	Y	AW	AW	C	1	95	RC	FR	M	WW	NR	CFC	SCR	5	100	PZ
F W Woolworth, Des Moines, Iowa	Y	AW	AW	C	1	93	RC	FR	M	WW	NR	DEC	SCR	2	60	PZ
W T Grant Co, Baltimore, Md.	S	....	....	...	2	90	RC	FR	M	CW	NR	....	...	...	...	...
Kirvin Invest Co, Columbus, Ga	Y	AW	AW,CC	C	1	90	RC	FR	M	CW	EC	DEC	SCR	2	50	PZ
F W Woolworth, Richmond, Va.	Y	AW	AW	C	3	88	RC	FR	M	CW	EC	DEC	SCR	2	60	PZ
McCrory Store, Washington, D.C.	S	DF	CC	C	1	87	RC	NH_3	M	CW	CT	CFC	...	1	25	...
F W Woolworth, St. Louis, Mo.	Y	AW	AW	C	1	87	RC	FR	M	CW	CT	DEC	SCR	2	60	PZ
F W Woolworth, New Haven, Conn.	Y	DF	CC	C	3	87	RC	FR	M	WW	NR	DEC	SCR	2	60	PZ
F W Woolworth, Washington, D.C.	Y	AW	AW	C	1	86	RC	FR	M	CW	EC	DEC	SCR	2	60	PZ
F W Woolworth, Phoenix, Ariz.	Y	DF	CC	C	1	85	RC	FR	M	CW	CT	DEC	SCR	3	70	PZ
J W Dorris, Phoenix, Ariz.	Y	DF	CC	C	2	85	RC	FR	M	CW	CT	DEC	SCR	5	50	AZI
McCrory Store, Wheeling, W.Va.	S	VF	CC	...	2	82.5	RC	FR	M	CW	EC	DEC	...	1	15	AS
W T Grant Co, Atlanta, Ga.	Y	VF	CC	C	2	81	RC	FR	M	CW	EC	DEC	SC	1	19	AZ
S & W Cafeteria, Knoxville, Tenn.	Y	DF	CC	...	2	80	RC	FR	M	CW	EC	DEL	SC	9	26	...
Lerner Store, Chicago, Ill.	Y	DF	CC	...	2	80	RC	FR	M	CW	NR	DEC	SC	2	25	AI
Cox Dry Goods Co, Waco, Tex.	Y	AW	AW,CC	C	2	80	RC	FR	M	CW	CT	DEC	SCR	2	40	PZ
Frieds Dept Store, New York, N.Y.	Y	DF	CC	C	2	80	RC	FR	M	CW	EC	CFC	SCR	4	70	PZ
Meyer, Israel & Co, New Orleans, La.	Y	DF	CC	C	4	80	RC	FR	M	CW	EC	DEL	SR	5	60	PI
F W Woolworth, Los Angeles, Cal.	Y	DF	CC	C	2	79	RC	FR	M	CW	EC	DEC	SCR	2	50	PZ
F W Woolworth, New York, N.Y.	Y	AW	AW	C	1	79	RC	FR	M	CW	CT	DEC	SCR	2	60	PZ
F W Woolworth, Atlanta, Ga.	Y	AW	AW	C	3	78	RC	FR	M	CW	EC	DEC	SCR	2	50	PZ
Neisner Bros, Inc, Irvington, N.Y.	Y	DF	CC	C	1	78	RC	FR	M	WW	NR	DEC	...	2	30	PZ
F W Woolworth, Trenton, N.J.	Y	AW	AW	C	1	77	RC	FR	M	CW	EC	DEC	SCR	2	50	PZ
F W Woolworth, Waco, Tex.	Y	AW	AW,CC	C	1	77	RC	FR	M	CW	CT	DEC	SC	3	50	AZ
F W Woolworth, Raleigh, N.C.	Y	AW	AW	C	2	76	RC	FR	M	CW	EC	DEC	...	2	40	PZ
S H Kress & Co, St Petersburg, Fla.	Y	DF	CC	...	3	75	RC	FR	M	CW	EC	DEC	...	1	23	AI
S H Kress & Co, Roanoke, Va.	Y	DF	CC	...	3	75	RC	FR	M	CW	EC	DEC	SC	1	27	AI
S H Kress & Co, Columbus, Ga.	Y	DF	CC	...	3	75	RC	FR	M	CW	EC	DEC	SC	1	21	AI
S H Kress & Co, Winston-Salem, N.C.	Y	DF	CC	...	3	75	RC	FR	M	CW	EC	DEC	...	1	20	AI
Lerner Store, Cincinnati, Ohio	Y	DF	CC	...	3	75	RC	FR	M	CW	EC	DEC	SC	1	20	AI
S H Kress & Co, Columbus, Ga.	Y	DF	CC	C	3	75	RC	FR	M	CW	EC	DEC	SC	1	25	PS
F W Woolworth, Evansville, Ind.	Y	AW	AW	C	1	74	RC	FR	M	WW	NR	DEC	SCR	2	50	PZ
F W Woolworth, Sacramento, Cal.	Y	DF	CC	C	1	71	RC	FR	M	WW	NR	DEC	SC	2	50	PZ
F W Woolworth, Springfield, Ill.	Y	AW	AW	C	1	66	RC	FR	M	WW	NR	CFC	SCR	3	60	PZ
F W Woolworth, Charleston, S.C.	Y	AW	AW	C	2	66	RC	FR	M	CW	EC	DEC	SCR	2	50	PZ

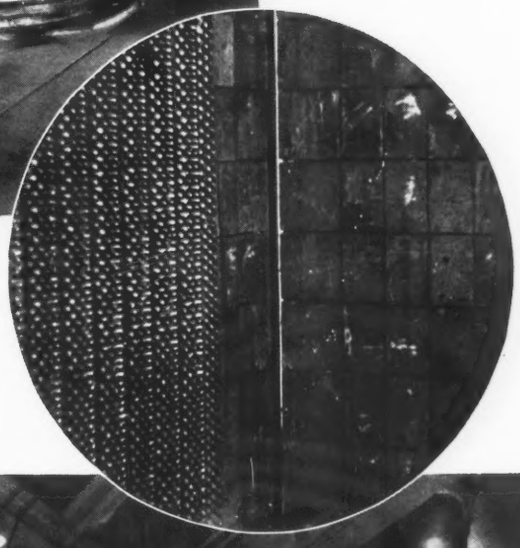
Owner and Location	Year-Round or Summer	Air-Cleaning Equipment	Dehumidifying Equipment	Humidifying	REFRIGERATION: No. of Units	Total Cap., Tons	Compressor Type	Refrigerant	Drive	Conden. Medium	Conden. Equipment	Transfer Equip.	Heating Method	No. of Fans	Tot. Fan Cap., 1000 cfm	Kind of Control	
S S Kresge, Harrisburg, Pa	S	DF	CC	...	3	65	RC	FR	M	CW	NR	DEC	...	1	14	AZ	STORES
Silvers Dept Store, Montgomery, Ala	Y	DF	CC	C	1	65	RC	FR	M	CW	CT	DEC	SCR	4	60	PZ	
F W Woolworth, Winston-Salem, N.C	Y	AW	AW	C	2	64	RC	FR	M	WW	NR	DEC	SCR	2	50	PZ	
McCrory Store, New Orleans, La	S	VF	CC	...	2	63	RC	FR	M	CW	EC	DEC	...	1	21	AI	
F W Woolworth, Knoxville, Tenn	Y	AW	AW	C	2	63	RC	FR	M	CW	EC	DEC	SCR	2	50	PZ	
F W Woolworth, Gary, Ind	Y	AW	AW	C	1	63	RC	FR	M	WW	CT	DEC	SCR	2	45	PZ	
F W Woolworth, Wellston, Mo	Y	AW	AW	C	1	62	RC	FR	M	CW	CT	DEC	...	...	...	PZ	
J W Thomas Co, Minneapolis, Minn	S	DF	CC	...	...	61	WW	H_2O	...	...	...	CFL	...	4	45	AZ	
F W Woolworth, Danville, Ill	Y	AW	AW	C	1	61	RC	FR	M	WW	EO	CFC	SCR	2	60	PZ	
Bon Marche' Store, Grand Rapids, Mich	S	VF	CC	...	1	60	WW	H_2O	...	...	...	DEC	...	1	25	PZ	
T F Condon & Sons, Charleston, S.C	Y	DF	CC	C	1	60	RC	FR	M	WW	CT	DEC	SCR	2	40	PZ	
Rutland's Store, St. Petersburg, Fla	S	VF	CC	...	1	60	RC	FR	M	CW	EC	DEC	SC	1	20	AS	
F W Woolworth, Orlando, Fla	Y	AW	AW	...	2	60	RC	FR	M	CW	EC	DEC	...	2	50	PZ	
905 Liquor Store, St. Louis, Mo	Y	DF	CC	...	3	60	RC	FR	M	CW	EC	DEC	SCR	1	20	PS	
F W Woolworth, Greenville, N.C	Y	AW	AW	C	2	60	RC	FR	M	CW	EC	DEC	SCR	3	50	PZ	
Alhambra Theatre, Hopkinsville, Tenn	S	VF	CC	...	3	60	RC	FR	M	CW	CT	DEC	SC	1	35	AS	
J C Penney Co, Oklahoma City, Okla	Y	DF	CC	C	3	60	RC	FR	M	WW	CT	DEC	SC	2	30	PZ	
Neisner Bros, Inc, Detroit, Mich	Y	VF	CC	...	2	60	RC	FR	M	WW	NR	DEC	...	2	25	PS	
F W Woolworth, Chicago, Ill	Y	DF	CC	C	1	59	RC	FR	M	WW	NR	DEC	SCR	2	40	PZ	
Schulte United, Atlanta, Ga	Y	VF	CC	...	2	58	RC	FR	M	CW	CT	DEC	...	2	28	AS	
F W Woolworth, Chicago, Ill	Y	DF	CC	C	1	56	RC	FR	M	CW	CT	DEC	SCR	2	40	PZ	
F W Woolworth, Topeka, Kan	Y	DF	CC	C	1	55	RC	FR	M	WW	NR	DEC	SCR	3	60	PZ	
F W Woolworth, Cleveland, Ohio	Y	DF	CC	C	1	55	RC	FR	M	CW	CT	DEC	SCR	2	40	PZ	
Galleria Bldg, St Louis, Mo	S	....	CC	...	2	55	RC	FR	M	...	...	DEC	...	...	...	...	
F W Woolworth, Lincoln, Neb	Y	AW	AW	C	1	55	RC	FR	M	WW	NR	CFC	SCR	2	50	PZ	
Meyer Greentree, Richmond, Va	Y	DF	CC	C	1	55	RC	FR	M	CW	EC	DEL	SR	8	20	PZ	
D F Peyton Co, Oklahoma City, Okla	S	VF	CC	...	3	55	RC	FR	M	CW	SP	DEC	...	3	18.2	AZ	
W T Grant, Wichita, Kan	Y	DF	CC	...	2	52.5	RC / WW	FR / H_2O	M	WW / ...	NR / NR	DEL / CFL	SC	2	18	AS	
F W Woolworth, Roanoke, Va	Y	AW	AW	C	3	51	RC	FR	M	WW	NR	CFC	SCR	2	50	PZ	
F W Woolworth, Rockford, Ill	Y	DF	CC	C	1	50	RC	FR	M	CW	CT	DEC	SCR	3	40	PZ	
W T Grant, Indianapolis, Ind	S	....	....	...	2	50	RC	FR	M	CW	EC	....	...	...	...	...	
S H Kress & Co, Lakeland, Fla	Y	DF	CC	...	2	50	RC	FR	M	CW	EC	DEC	SC	1	15.9	AI	
Lerners Store, Detroit, Mich	S	VF	CC	...	2	50	RC	FR	M	CW	NR	DEC	...	2	20	PS	
Lerner Store, Washington, D.C	Y	DF	CC	...	2	50	RC	FR	M	CW	NR	DEC	SC	1	16.5	AI	
Neisner Bros, Inc, Royal Oak, Mich	S	....	....	...	1	50	RC	FR	M	CW	NR	....	...	...	...	...	
Neisner Bros, Inc, Sioux City, Iowa	Y	VF	CC	...	2	50	RC	FR	M	CW	NR	DEC	SC	2	14	AZ	
John Wanamaker, Philadelphia, Pa	S	DF	CC	...	2	50	RC	FR	M	CW	NR	DEC	...	2	12	AZ	
J J Newberry Co, Columbus, Ga	S	DF	CC	...	2	50	RC	FR	M	CW	EC	DEC	...	1	20	PZ	
McCrory Store, Wilkes-Barre, Pa	Y	DF	CC	...	2	50	RC	FR	M	CW	EC	DEC	...	1	20	AZ	
Lerner Store, New York, N.Y	Y	DF	CC	...	2	50	RC	FR	...	CW	NR	DEC	SC	1	10.8	AI	
Shulte Uni ed, Baltimore, Md	S	....	....	...	1	50	RC	FR	M	CW	EC	....	...	...	...	...	
S H Kress & Co, Montgomery, Ala	Y	DF	CC	C	2	50	RC	FR	M	CW	EC	DEC	SC	1	30	PS	
S H Kress & Co, Macon, Ga	Y	DF	CC	C	2	50	RC	FR	M	CW	EC	DEC	SC	1	20	PS	
Feller & Co, Harrisburg, Pa	Y	DF	CC	C	2	50	RC	FR	M	CW	NR	DEC	SC	1	13	AZ	
S H Kress & Co, Montgomery, Ala	Y	DF	CC	...	2	50	RC	FR	M	CW	EC	CFC	SC	1	33.7	AI	
Sears Roebuck & Co, Tampa, Fla	Y	VF	CC	...	2	50	RC / WW	FR / H_2O	M	WW / ...	NR / SP	DEC	...	...	...	...	
Maas the Haberdasher, Tampa, Fla	Y	DF	CC	...	2	50	RC	FR	M	CW	EC	DEC	...	1	13.7	A[I]	
Ford Motor Co, Louisville, Ky	S	VF	CC	...	2	50	WW / RC	H_2O / FR	... / M	WW / CW	NR / NR	DEC	...	2	...	AZ	
Bergdorf-Goodman, New York, N.Y	Y	DF	CC	C	1	50	RC	FR	M	CW	CT	DEL	SR	16	10	PI	
McCrory Store, Morgantown, W.Va	S	VF	CC	...	1	50	RC	FR	M	CW	CT	DEC	...	1	20	AS	
Sears Roebuck & Co, Sacramento, Cal	Y	VF	CC	...	2	50	RC	FR	M	CW	NR	DEC	SC	...	...	...	
Paris Shop, Cincinnati, Ohio	S	VF	CC	...	2	50	RC	FR	M	CW	EC	DEC	...	5	...	AS	
McCrory Store, Huntingdon, W.Va	S	VF	CC	...	2	50	RC	FR	M	CW	EC	DEC	...	2	15	AS	
F W Woolworth, Cleveland, Ohio	Y	DF	CC	C	1	50	RC	FR	M	WW	NR	DEC	SC	1	25	AZ	
Hart Albin Store, Billings, Mont	Y	AW	AW	C	1	50	RC	FR	M	WW	NR	DEC	SCR	4	40	PZ	
S H Kress & Co, Florence, S.C	Y	DF	CC	...	2	50	RC	FR	M	CW	EC	DEC	SC	1	14.1	AI	
S H Kress & Co, Macon, Ga	Y	DF	CC	...	2	50	RC	FR	M	CW	EC	DEC	...	1	17	AI	
Lerner Store, Detroit, Mich	Y	DF	CC	...	2	50	RC	FR	M	CW	NR	DEC	SC	2	13	AI	
Capitol Power Plant, Washington, D C	Y	AW,DF	AW,CC	C	6	4800	RC	FR	M	WW	NR	CFCL	SCR	...	...	PZI	OFFICES
Nemours Bldg, Wilmington, Del	Y	AW	AW	C	2	600	RC	FR	M	CW	CT	CFL	SR	30	500	PZI	
Detroit Edison Co, Detroit, Mich	Y	AW,DF	AW,CC	C	2	540	CE	CA	M	CW	NR	CFC	WC	6	200	AI	
Equitable Life Ins Co, Des Moines, Iowa	S	DF,VF	CC	C	2	485	CE	H_2O	M	CW	CT	....	...	...	...	AZ	
Medical Arts Bldg, Dallas, Tex	Y	AW,DF	AW	C	2	400	CE	CA	M	CW	CT	CFC	SC	22	132	AZ	
Shell Petroleum Bldg, St Louis, Mo	Y	AW	AW	C	2	383	RC	FR	M	CW	CT	CFC	SC	14	280	AZI	
Kennedy Building, Tulsa, Okla	Y	DF	CC	C	1	360	SJ	H_2O	...	CW	CT	....	WC	24	150	AZ	
First National Bank, Mobile, Ala	Y	AW,DF	AW,CC	C	1	350	CE	CA	M	WW	NR	CFC	SC	10	100	AZ	
Ralston Purina Co, St. Louis, Mo	Y	DF	CC	C	1	350	CE	H_2O	ST	CW	CT	....	SR	8	80	AIS	
Phillips Pet Corp, Bartlesville, Okla	Y	DF	CC	C	1	350	CE	CA	M	CW	CT	CFC	WC	25	131	AZ	
Wrigley Bldg, Chicago, Ill	Y	AVF	CC	C	1	340	CE	H_2O	M	CW	NR	CFC	WR	...	...	A	
Missouri Theatre Bldg, St Louis, Mo	Y	DF	CC	C	12	315	RC	FR	M	CW	CT	DEC	...	22	126	PS	
Trust Co of Ga., Atlanta, Ga	Y	VF	CC	C	1	300	CE	CA	M	CW	CT	CFC	WC	15	140	AZ	
Hershey Chocolate Corp, Hershey, Pa	Y	AW,DF	AW,CC	C	2	300	RC	FR	M	WW	NR	CFC	SC	20	750	AIZ	
Continental Bldg, St Louis, Mo	Y	DF,VF	CC	C	20	300	RC	FR	M	CW	CT / SP	CFC	WC	20	96	AZ	
Mellon Nat'l Bank, Pittsburgh, Pa	S	....	....	...	2	280	CE	H_2O	M	CW	NR	....	...	...	...	...	
Nelson Art Gallery, Kansas City, Mo	S	AVF	CC	C	2	250	CE	H_2O	ST	CW	NR	CFC	SCR	7	205	AZ	
First Nat'l & Trust Co, Tulsa, Okla	Y	DF	CC	C	1	231	CE	CA	M	CW	CT	CFC	WC	9	53	AZ	
Queens County Courthouse, New York, N.Y	S	....	....	...	2	225	RC	FR	M	...	...	CFL	...	...	...	...	
Rice Bldg, Boston, Mass	Y	VF	CC	C	2	200	RC	FR	M	CW	CT	CFL	SR	8	200	AZI	
Retail Credit Co, Atlanta, Ga	Y	AW,VF	AW,CC	C	1	190	CE	CA	M	CW	CT	CFC	SC	1	30	AZ	
Mayo Bldg, Tulsa, Okla	Y	DF	CC	C	1	186	RC	FR	M	CW	CT	DEL	SR	33	90	PZI	
Dollar Savings Bank, New York, N.Y	S	....	....	...	4	172	RC	FR	M	CW	NR	CFL	...	...	...	...	
Federal Land Bank, New Orleans, La	Y	VF	CC	...	2	160	RC	FR	M	CW	CT	CFC	SC	6	48	AZ	
Proctor & Gamble Co, Cincinnati, Ohio	Y	AW,VF	AW	C	1	160	CE	CA	M	CW	CT	CFC	SC	8	40	ASZ	
Acme Steel Corp, Riverdale, Ill	S	....	....	...	3	156	RC	FR	M	CW	NR	....	...	...	...	...	
Skelly Oil Co, Tulsa, Okla	Y	VF	CC	C	1	155	CE	H_2O	M	CW	CT	CFC	WC	10	60	AZ	
Brix Bldg, Fresno, Calif	Y	AW,DF	AW,CC	C	1	150	WW / RC	H_2O / FR	M	CW	CT	DEC	SC	3	90	PZ	
Columbus RR, Light & Power Co	S	....	....	...	3	150	RC	FR	M	CW	EC	DEL	...	...	...	...	
Bureau of Engraving & Prtg, Wash., D.C	S	....	....	...	1	145	RC	FR	M	CW	NR	CFL	...	...	...	...	
First Nat'l Bank, Dallas, Tex	Y	AW	AW	C	3	140	RC	FR	M	CW	CT	DEC	SCR	10	100	PZ	
Hershey Chocolate Corp, Hershey, Pa	Y	AW	AW	C	1	135	RC	FR	M	WW	CT	CFC	SC	3	80	AZI	
J P Morgan Co, New York, N.Y	Y	VF	CC	C	5	130	RC	FR	M	CW	NR	CFC	SC	3	52	AZ	
24 Federal St Bldg, Boston, Mass	Y	AW	AW,CC	C	1	125	RC	FR	M	CW	EC	CFC	SCR	3	70	AZI	
Ford Motor Co, Detroit, Mich	S	....	CC	...	3	121	RC	FR	M	...	...	DEC	...	...	...	...	
S A Pub Serv Co, San Antonio, Tex	Y	DF	CC	C	3	120	RC	FR	M	CW	EC	CFC	...	...	...	PZI	
Wash. Water Power Co, Spokane, Wash	Y	DF	CC	C	3	120	RC	FR	M	WW	NR	DECL	SCR	7	50	PZI	
Cottonbelt Bldg, St Louis, Mo	Y	DF	CC	C	3	120	RC	FR	M	CW	CT	DEC	SR	...	...	PZI	
Eli Lilly & Co, Indianapolis, Ind	Y	DF	CC	C	...	120	WW	H_2O	...	WW	NR	CFC	SC	2	33	PZ	
Ambassador Bldg, St Louis, Mo	Y	DF	CC	C	3	120	RC	FR	M	CW	EC	DEC	SCR	4	61	PS	

A — absorption system
AI — automatic individ. control
AS — automatic single control
AZ — automatic zone control
AVF — automatic viscous filter
AW — air washer
BS — brine spray
C — central dehumidification
CA — Carrene
CC — cooling coil
CE — centrifugal compressor
CFC — chilled fluid — central
CFL — chilled fluid — local
CFCL — both CFC & CFL
CO_2 — carbon dioxide
CT — cooling tower
CW — city water
D — direct humidifying (in room)
DE — diesel engine
DF — dry filter
DEC — direct expansion — central
DEL — direct expansion — local
DECL — both DEC & DEL
EC — evaporative condenser
FR — Freon
GE — gas engine
H_2O — water
M — motor
MI — manual individual control
MS — manual single control
MZ — manual zone control
NH_3 — ammonia
NR — no recirculation
PI — semi-auto. individ. control
PS — semi-auto. single control
PZ — semi-auto. zone control
RC — reciprocating compressor
RO — rotary compressor
S — summer cooling only
SC — steam coils in duct–central
SCL — both steam coils & radiation
SE — steam engine
SG — silica gel
SJ — steam-jet compressor
SL — steam radiation — local
SO_2 — sulphur dioxide
SP — spray pond
ST — steam turbine
SW — sea water
VF — viscous filter
WC — hot-water coils in duct
WL — hot-water radiation
WS — water spray
WW — well water
Y — year-round conditioning

	Owner and Location	Year-Round or Summer	Air-Cleaning Equipment	Dehumidifying Equipment	Humidifying	REFRIGERATION: No. of Units	Total Cap., Tons	Compressor Type	Refrigerant	Drive	Conden. Medium	Conden. Equipment	Transfer Equipment	Heating Method	No. of Fans	Tot. Fan Cap., 1000 cfm	Kind of Control
OFFICES	Court of Appeals, Washington, D.C.	S	....	....	...	3	115	RC	FR	M	CW	EC	CFL	...	...	...	...
	Laclede Gas Light Co, St Louis, Mo.	Y	VF	SG	...	...	110	RC	FR	M	CW	CT	DEC	...	...	...	AS
	Appellate Div Supreme Court, Wash., D.C.	S	....	....	...	3	105	RC	FR	M	CW	CT	CFC	...	...	...	...
	Standard Oil Bldg, Shreveport, La.	Y	AW	AW,CC	C	2	103	RC	FR	M	WW	CT	DEC	SR	5	50	PZI
	Humbolt Bldg, St Louis, Mo	Y	DF	CC	C	4	100	RC	FR	M	CW	EC	CFC	...	5	40	PS
	Palm Olive Bldg, Chicago, Ill.	S	....	....	...	2	100	RC	FR	M	CW	EC	CFL	...	...	...	...
	Nat'l Broadcasting Co, Philadelphia, Pa.	Y	AW,DF	AW,CC	C	4	100	RC	FR	M	CW	EC	DEC	SC	1	23.5	AI
	Comm Travelers Bldg, Utica, N.Y.	Y	VF	CC	C	3	95	RC	FR	M	CW	CT	DEC	...	6	41.3	AZ
	Ford Motor Co, New York, N.Y.	Y	AW	AW,CC	C	2	94	RC	FR	M	CW	CT	CFC	SCR	4	40	PZI
	W C Ellis Bldg. Phoenix, Ariz.	Y	DF	CC	C	2	90	RC	FR	M	WW	CT	DECL	SR	2	50	PZI
	Emigrant Bank, New York, N.Y.	S	....	....	...	6	90	RC	FR	M	CW	NR	....	...	...	...	...
	Dixie Terminal Bldg, Cincinnati, Ohio.	Y	DF	CC	C	2	85	RC	FR	M	...	...	CFC	WC	7	41	AZ
	Zenith Radio Corp, Chicago, Ill.	Y	DF	CC	C	2	82	RC	FR	M	...	...	CFC	WC	7	41	AZ
	Wheeler Dam, Sheffield, Ala.	Y	AW	AW,CC	C	...	80	WW	H_2O	M	...	...	....	...	2	40	AZ
	Fulton Savings Bank, New York, N. Y.	Y	DF	CC	C	2	80	RC	FR	M	CW	CT	CFC	...	...	...	PZI
	Mariner Bldg, Milwaukee, Wis.	Y	AW	AW,CC	C	2	80	RC	FR	M	WW	CT	DEC	SCR	...	...	AZI
	Cokesbury Bldg, Dallas, Tex.	Y	AW	AW,CC	C	2	80	RC	FR	M	CW	CT	DEC	SCR	2	40	PZI
	Rand Tower, Minneapolis, Minn.	S	VF	CC	...	2	80	RC	FR	M	CW	NR	DEC	...	1	32	AZ
	National Supply Co, Tulsa, Okla.	Y	DF	CC	C	2	80	RC	FR	M	CW	EC	DEC	WC	2	25	AZ
	St Louis Daily Record, St Louis, Mo	Y	DF	CC	C	3	75	RC	FR	M	CW	EC	DEC	SCR	5	36	PZ
	Kansas Gas & Elec Co, Wichita, Kan	Y	DF	CC	...	4	75	{RC / WW}	{FR / H_2O}	M	WW	NR	{DEL / CFC}	SC	4	25	AZ
	First Wis Nat'l Bank, Milwaukee, Wis.	Y	DF	CC	C	3	75	RC	FR	M	CW	SP	DECL	SC	1	24.3	AZ
	Cent Hudson Gas & Elec Co, P'keepsie, N.Y.	Y	VF	CC	C	2	73	RC	FR	M	CW	EC	DEC	SC	3	37	AZ
	Public Service Co, Passaic, N.J.	Y	VF	CC	C	4	69	RC	FR	M	CW	EC	DEC	SCR	3	30	AI
	Guardian Life Ins Co, Dallas, Tex.	Y	VF	CC	C	2	68	RC	FR	M	CW	SP	DEC	SC	1	28	AZ
	Mellon Securities Bldg, Pittsburgh, Pa.	S	AVF	CC	C	3	65	RC	FR	M	CW	NR	DEC	SWC	6	32.5	...
	G R Gas Light Co, Grand Rapids, Mich.	Y	VF	SG	...	...	64	WW	H_2O	...	...	...	CFC	...	...	...	AZ
	James R Kearney Corp, St Louis, Mo.	S	DF	CC	C	1	62	RC	FR	M	CW	EC	DEC	SC	1	...	AZ
	N Penn Gas Co, Port Alleghany, Pa.	Y	VF	SG	...	...	61	WW	H_2O	...	...	...	CFC	WC	...	...	AS
	Pepperell Mfg Co, New York, N.Y.	S	VF	CC	C	3	60	RC	FR	M	CW	NR	DEC	SC	1	27	AZ
	Fidelity Union Trust Co, Newark, N.J.	Y	BS	BS	C	1	60	....	BS	...	CW	NR	CFC	SC	1	12	AS
	Fort Howard Paper Co, Green Bay, Wis.	S	....	CC	...	1	60	RC	NH_3	SE	...	...	CFC	...	...	...	...
	Ford Motor Co, Edgewater, N.J.	Y	DF	CC	C	1	55	RC	FR	M	WW	CT	DEC	SCR	4	50	PZI
	Trenton Times, Trenton, N.J.	Y	DF	CC	C	4	55	RC	FR	M	WW	NR	DEL	SR	8	40	PI
	Ford Motor Co, Chester, Pa.	Y	AW	AW,CC	C	1	55	RC	FR	M	WW	CT	DEC	SCR	4	50	PZI
	Ford Motor Co, Norfolk, Va.	Y	DF	CC	C	1	54	RC	FR	M	WW	NR	DEC	SC	3	25	AZ
	Wash. Gas Light Co, Washington, D.C.	Y	VF	SG	...	...	54	WW	H_2O	...	...	...	CFC	...	...	...	AS
	Peoples Power Co, Moline, Ill.	Y	VF	SG	...	...	51	WW	H_2O	...	...	...	CFC	...	...	...	AZ
	R I Hosp Trust Co, Providence, R.I	Y	VF	CC	C	3	50	RC	FR	M	CW	CT	DEC	SCR	2	24	AZ
	U S P O & Courthouse, Little Rock, Ark.	Y	DF	CC	C	2	50	RC	FR	M	WW	NR	CFC	SCR	3	40	AZI
	N Y Pwr & Light Co, Albany, N.Y.	S	VF	SG	...	...	50	RC	FR	M	...	...	DEC	...	...	...	AS
	Ohio Bell Tel Co, Cleveland, Ohio.	S	....	....	...	2	50	RC	FR	M	CW	NR	....	...	...	...	...
	Thompson Bldg, Tulsa, Okla.	Y	DF	CC	C	2	50	RC	FR	M	CW	EC	DEC	SC	1	18	AZ
	Reliance Mfg Co, Chicago, Ill.	S	AW,DF	AW,CC	C	2	50	RC	FR	M	CW	CT	DEC	S	...	...	...
	Pasteur Medical Bldg, St Louis, Mo	Y	DF	CC	...	2	50	RC	FR	M	CW	NR	DEC	SCR	1	15	PZ
	Bloomfield Savings Bank, N.J.	Y	AW,VF	AW,CC	C	3	50	RC	FR	M	CW	EC	CFC	WC	3	15	AI
	Fulton Iron Works, St Louis, Mo.	S	VF	CC	...	2	50	RC	FR	M	CW	EC	DEL	...	2	20	PS
INDUSTRIAL	Standard Fruit & S S Co, New Orleans, La.	Y	....	....	...	8	1300	SJ	H_2O	...	SW	NR	CFL	W	44	1130	MI
	Pittsburgh Stock Yds, Pittsburgh, Pa.	Y	DF,WS	WS	WS	4	450	RC	NH_3	M	WW	SP	{DEL / CFL}	...	9	90	PSI
	Helms Bakery, Los Angeles, Calif.	Y	AW	AW	C	2	257	RC	FR	M	CW	CT	CFCL	SCR	6	200	PZI
	Beechnut Packing Co., Brooklyn, N.Y.	Y	....	....	...	3	256	CE	H_2O	M	CW	NR	....	...	...	...	...
	Rectigraph Co, Rochester, N. Y.	Y	AW,DF	AW,CC	CD	1	250	RC	NH_3	M	CW	CT	CFCL	SC	6	150	PZI
	Grocery Products Co, W. Chester, Pa.	Y	VF	CC	...	9	180	RC	FR	M	WW	CT	DEC	...	...	...	PS
	Brewing Corp of America, Cleveland, Ohio.	Y	DF	CC	...	...	180	CE	CA	M	CW	CT	CFL	SR	14	64	AZ
	General Cigar Co, New Brunswick, N.J.	Y	DF	CC	C	2	163	RC	FR	M	WW	CT	CFCL	...	...	...	PI
	Kingan & Co, Richmond, Va.	Y	AW	AW,CC	...	2	160	RC	NH_3	M	WW	CT	DEC	...	2	30	MS
	Chris Housen's Lab, Little Falls, N.Y.	Y	AW	AW	C	2	126	WW	H_2O	...	WW	NR	....	SC	4	53	AI
	American Cyanamide Co, Bound Brook, N.J.	Y	VF	SG	...	...	120	RC	FR	M	CW	NR	DEC	...	...	...	AS
	Agfa Ansco Corp, Binghamton, N.Y.	Y	AW,DF	AW,CC	C	...	113	WW	H_2O	...	...	...	....	SC	4	42.7	AI
	N E Chem Ind, Inc, N Woburn, Mass.	Y	....	....	...	...	109	WW	H_2O	...	...	...	....	SC	2	132	MI
	Ford Motor Co, Dearborn, Mich.	Y	....	CC	...	2	100	RC	NH_3	M	WW	CT	DEC	...	...	...	MI
	Ciba Pharm Co, Summit, N.J.	Y	AW	AW	C	...	100	WW	H_2O	M	...	...	....	SC	1	35	AS
	St Louis Dairy Co, St Louis, Mo.	Y	DF	AW,CC	CD	1	100	RC	NH_3	M	WW	CT	DECL	...	9	20	PSI
	Bristol Myers Co, Hillside, N.J.	Y	AW,VF	AW,CC	D	2	95	RC	NH_3	M	CW	EC	DEC	SR	1	42.4	AI
	Lehman Packing Co, Brooklyn, N. Y.	Y	WS,DF	WS,CC	...	1	80	RC	NH_3	SE	WW	CT	DEL	...	12	30	PI
	U S Bur Mines, Bartlesville, Okla	Y	DF	CC	C	3	75	RC	FR	M	CW	NR	DEC	SC	1	30	AZ
	American Decalcomania Co, Chicago, Ill.	Y	AW	AW	C	1	70	CE	CA	M	CW	CT	CFC	SC	1	39	AZ
	Armstrong Cork Co, Lancaster, Pa.	Y	VF	SG	...	...	65	...	...	...	...	...	...	...	...	...	AS
	Yakima Co, Natchez, Wash.	Y	AW	AW,CC	...	1	60	RC	NH_3	M	WW	CT	DEC	...	2	30	MS
	Hartford Rayon Corp, Rocky Hill, Conn.	Y	....	....	...	1	60	SJ	H_2O	...	WW	NR	....	...	...	...	...
	Kroger Grocery, Peoria, Ill.	Y	DF	CC	D	3	50	RC	NH_3	M	WW	CT	DEL	SR	9	10	ASI
	Yakima Co, Tieton, Wash.	Y	AW	AW,CC	...	1	50	RC	NH_3	M	WW	CT	DEC	...	2	20	MS
	Hamilton Watch Co, Lancaster, Pa.	Y	DF	CC	...	2	50	RC	FR	M	CW	NR	DEC	SC	2	22	AZ
	Woodward Tiernan Printing Co.	Y	VF	SG	...	...	50	RC	FR	M	CW	CT	DEC	...	...	...	AS
	Crosley Radio Corp, Cincinnati, Ohio.	Y	DF	CC	C	2	50	RC	FR	M	CW	EC	DEC	SC	1	13.5	AS
	Pixley & Ehlers, Chicago, Ill.	S	....	CC	...	4	100	RC	FR	M	...	...	DEC	...	...	...	...
HOTELS & RESTAURANTS	International Casino, New York, N.Y.	Y	DF	CC	C	3	150	RC	FR	M	CW	NR	DEL	SC	...	...	...
	Stouffer Restaurant, New York, N.Y.	Y	VF	CC	C	2	65	RC	FP	M	CW	CT	DEC	SC	4	26.9	AI
	Maramor Restaurant, Columbus, Ohio.	Y	VF	SG	...	...	52	WW	H_2O	...	...	...	CFC	...	...	...	AZ
	Southern Mansion Rest'r't, Kansas City, Mo	S	....	CC	...	2	50	RC	FR	M	...	...	DEC	...	...	...	...
	Eitel Restaurant, Chicago, Ill.	S	VF	CC	...	3	50	RC	FR	M	CW	NR	DEC	...	3	18	AZ
	Palmer House, Chicago, Ill.	Y	AW	AW,CC	C	1	870	CE	CA	M	CW	NR	CFC	WC,SR	60	300	AI
	Mayflower Hotel, Washington, D.C.	Y	AW	AW,CC	C	3	300	RC	FR	M	CW	CT	CFCL	SCR	5	105	PZI
	St Anthony Hotel, San Antonio, Tex.	Y	AW,DF	AW	C	3	350	RC	FR	M	WW	NR	CFC	SC	8	73	AI
	Fontelle Hotel, Omaha, Neb.	Y	AW,VF	AW,CC	C	4	300	RC	{FR / NH_3}	M	CW	CT	{DEC / CFC}	SC	8	118	PI
	G Washington Hotel, Jacksonville, Fla.	Y	AW,DF	AW,CC	C	1	300	CE	CA	M	CW	CT	CFL	WR	15	140	AIZ
	Statler Hotel, St Louis, Mo.	S	....	....	...	5	280	RC	FR	M	CW	CT	DECL	SC	9	26	...
	Jung Hotel, New Orleans, Fla.	Y	DF	CC	C	2	250	RC	FR	M	CW	CT	CFCL	SR	...	...	PI
	St Regis Hotel, New York, N.Y.	Y	DF	AW,CC	C	2	220	RC	FR	M	CW	CT	CFCL	SR	4	120	PZI
	Park Plaza Hotel, St Louis, Mo.	S	AW,DF	AW	C	1	220	CE	H_2O	ST	CW	CT	{DEC / CFC}	SCR	...	...	...
	Adolphus Hotel, Dallas, Tex.	Y	AW	AW	C	2	200	RC	FR	M	WW	NR	CFL	SR	...	...	PI
	Carleton Hotel, Washington, D.C.	S	AW,VF	AW,CC	...	4	183	RC	FR	M	CW	EC	CFC	...	6	40	AZ
	Baker Hotel, Dallas, Tex.	Y	AW	AW	C	1	175	RC	FR	M	WW	NR	CFL	SR	...	...	PI
	Hotel Bentley, Alexandria, La.	Y	DF	CC	C	1	150	CE	CA	ST	CW	CT	CFC	WC	10	51	AI
	Ben Milam Hotel, Houston, Tex.	Y	AW	AW	C	2	130	RC	FR	M	CW	CT	CFCL	SCR	6	60	AZI
	Plaza Laredo, Laredo, Tex.	Y	AW	AW,CC	C	2	125	RC	FR	M	WW	CT	DEC	...	6	60	AZI
	Harrington Hotel, Washington, D.C.	Y	DF	CC	C	2	120	{WW / RC}	{H_2O / FR}	M	WW	NR	CFC	...	1	30	AZ
	William Penn Hotel, Pittsburgh, Pa.	Y	VF	CC	...	1	100	RC	FR	M	CW	NR	DEC	SC	3	16	PI
	Youngblood Hotel, Enid, Okla.	Y	AW	AW,CC	C	2	90	RC	FR	M	WW	CT	DECL	SR	5	40	PI
	Ketchum Hotel, Tulsa, Okla.	S	VF	CC	...	2	85	RC	FR	M	CW	SP	DEC	...	1	39	AZ
	Washington Youvee Hotel, Shreveport, La.	Y	AW	AW	C	2	85	RC	FR	M	WW	CT	CFC	SR	2	40	PI
	Mark Hopkins Hotel, San Francisco, Calif.	Y	DF	CC	C	2	85	RC	FR	M	CW	EC	DEC	...	3	50	PZI
	Belmont Plaza, New York, N.Y.	S	....	....	...	2	80	RC	FR	M	CW	NR	....	...	...	...	...
	Melbourne Hotel, St Louis, Mo.	S	....	....	...	2	80	RC	FR	M	CW	EC	CFC	...	...	...	...
	Hampshire House, New York, N.Y.	Y	VF	CC	C	4	66	RC	FR	M	CW	EC	DEC	SC	4	17	AZ
	St Regis Hotel, New York, N.Y.	Y	DF	CC	C	1	60	RC	FR	M	CW	CT	CFC	SCR	4	40	PI
	Bristol Hotel, New York, N.Y.	Y	VF	CC	...	5	60	SJ	H_2O	...	CW	NR	CFL	SR	5	20	PSI
	Hotel Astor, New York, N.Y.	S	....	....	...	3	60	RC	FR	M	CW	NR	....	...	...	...	...
	Park Central Hotel, New York, N.Y.	Y	DF	CC	C	2	55	RC	FR	M	CW	CT	DEL	SR	3	25	PZ
	Alcazar Hotel, Miami, Fla.	Y	DF	CC	C	3	55	RC	FR	M	CW	EC	DECL	...	3	25	PI
	Lexington Hotel, New York, N.Y.	S	AW,DF	AW,CC	C	1	55	RC	CO_2	M	CW	NR	{DEC / CFC}	SC	1	14	MS
	Hotel Casey, Scranton, Pa.	Y	DF	CC	C	3	50	RC	FR	M	CW	NR	DEC	SC	3	14	AZ
	New Chicagoan Hotel, Chicago, Ill.	S	....	CC	...	2	50	RC	FR	M	...	...	DEC	...	...	...	...



Pulverizers are motordriven through multiple Vee belts



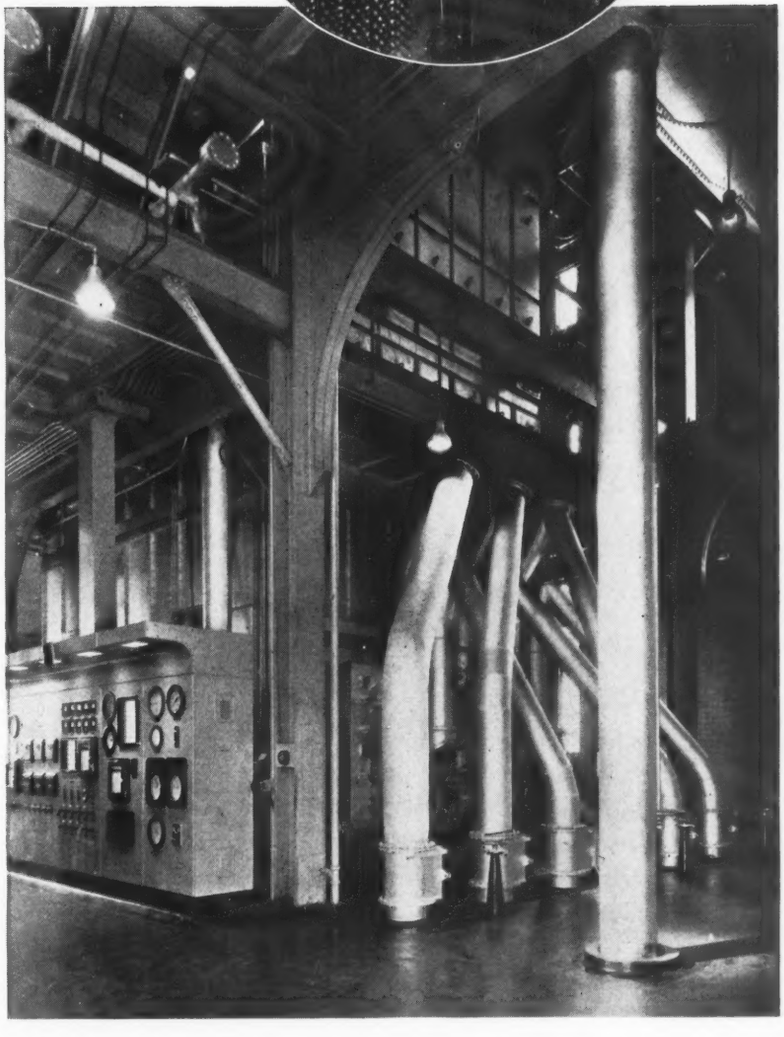
Below — Furnace-wall construction, showing, at right, Bailey blocks on rear wall and, at left, side-wall stud tubes before application of plastic chrome ore

NEAT and NEW

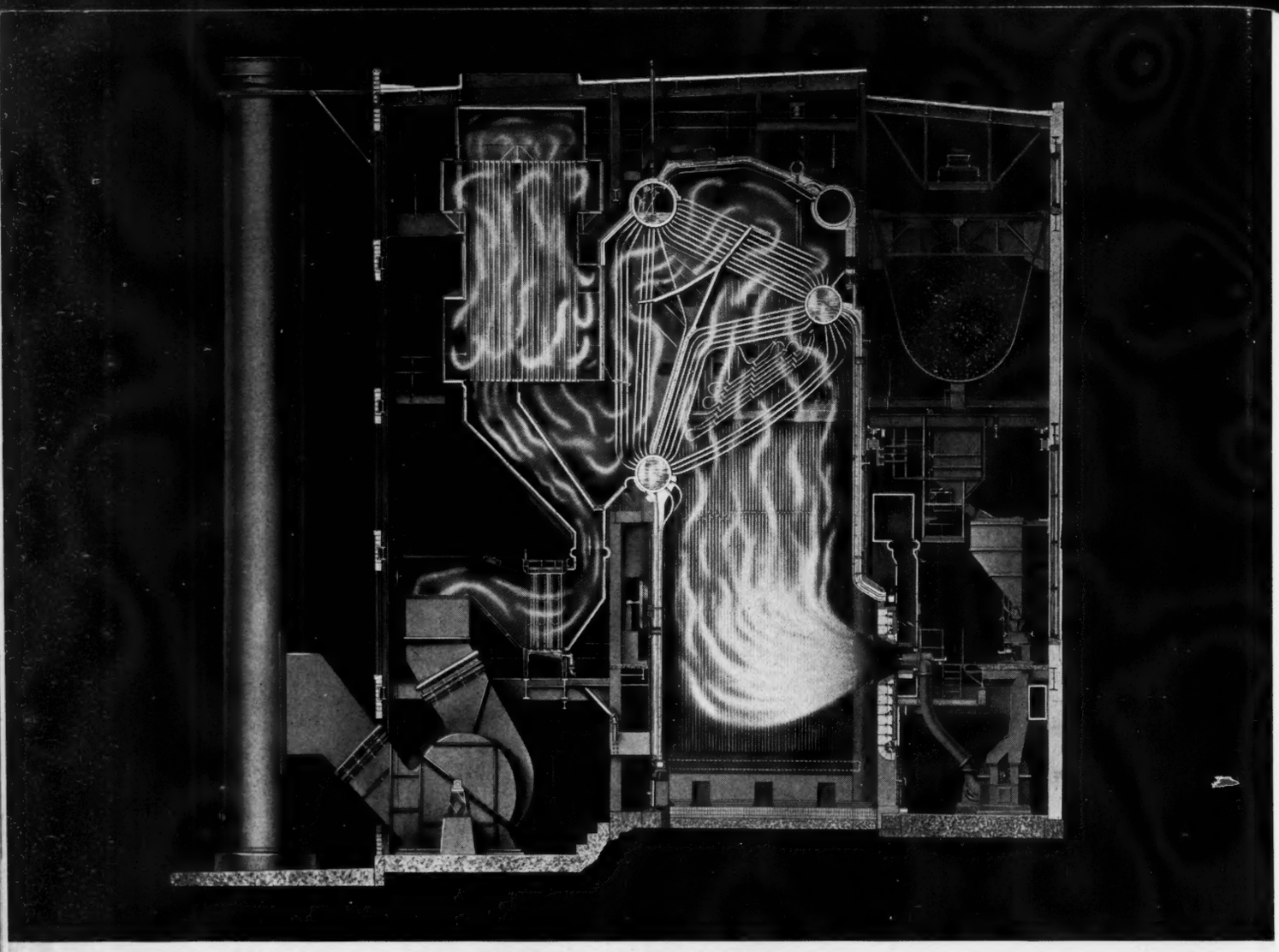
MILLERS FORD new high-pressure "top," Dayton (Ohio) Power and Light Co, catches the eye with its neat layout and clean finish, holds the attention with its engineering features, including electrostatic precipitation. Its two straight-tube boilers are equipped with economizers, air heaters, and damper super-heat control. Each generates a maximum of 375,000 lb per hr at 1250 lb and 900 F.

Forced and induced-draft fans are motor driven. The 25,000-kw hydrogen-cooled topping turbine runs at 3600 rpm.

Photos show Babcock Wilcox boiler, pulverizers and furnace walls.



High-head boiler, cross-tube burners and metering and control equipment



For Capacities from 150,000 lbs. of steam per hour up
THE RILEY HIGH CAPACITY HIGH EFFICIENCY STEAM GENERATING UNIT

RILEY HAS MORE THAN KEPT PACE

with recent advances in boiler design

...that is why there continues to be such a definite SWING to **RILEY** equipment

The engineering profession is quite generally talking of the tremendous progress Riley has made during the past five or six years in the boiler industry, both as to design and number of units installed. Riley has very definitely more than kept pace with the rapid advances made in boiler design and construction. Riley units today are modern, highly efficient units with plus values which assure entirely satisfactory results, often exceeding the expectations of the purchaser.

Sales volume, after all, is the best barometer of the progress of a company in an industry. Riley sales started a decided climb when the swing to Riley started in 1931, far before any general business improvement. The fact that sales each year have increased substantially beyond that of the boom period of 1929 establishes the general acceptance of modern Riley units and the unusual results being obtained from recent Riley installations.

A visit to recent Riley installations will clearly explain why there has been such a decided swing to Riley. You owe it to yourself and your company to thoroughly investigate Riley equipment when considering boiler plant improvements.

LIST OF A FEW RECENT INSTALLATIONS

RILEY

STEAM GENERATING UNITS

High Capacity High Efficiency Units

Central Illinois Light Co., Peoria, Ill.
1—300,000 lbs./hr.—900 lbs.
Lynn Gas & Electric Co., Lynn, Mass.
1—205,000 lbs./hr.—450 lbs.
Otter Tail Power Co., Wahpeton, N. D.
1—130,000 lbs./hr.—600 lbs.
Holyoke Water Power Co., Holyoke, Mass.
1—170,000 lbs./hr.—675 lbs.
Fort Bend Utilities, Sugarland, Texas
1—160,000 lbs./hr.—450 lbs.
W. Va. Pulp & Paper Co., Covington, Va.
2—375,000 lbs./hr. each—600 lbs.
W. Va. Pulp & Paper Co., Luke, Md.
2—375,000 lbs./hr. each—650 lbs.
W. Va. Pulp & Paper Co., Charleston, S. C.
2—225,000 lbs./hr. each—600 lbs.
W. Va. Pulp & Paper Co., Williamsburg, Pa.
2—71,500 lbs./hr. each—600 lbs.
Large Eastern Oil Refinery
2—300,000 lbs./hr. each—650 lbs.
Humble Oil & Refining Co., Baytown, Texas
1—350,000 lbs./hr.—675 lbs.
Standard Oil Co. of Calif., Richmond, Calif.
3—125,000 lbs./hr. each—900 lbs.
Bahrein Petroleum Co., Persian Gulf
2—106,000 lbs./hr. each—600 lbs.
Celanese Corp. of Amer., Cumberland, Md.
2—200,000 lbs./hr. each—475 lbs.
Libby Owens Ford Glass Co., Rossford, O.
1—175,000 lbs./hr.—450 lbs.
Publicker Comm. Alcohol Co., Phila., Pa.
1—275,000 lbs./hr.—475 lbs.
MacAndrews & Forbes Co., Camden, N. J.
2—100,000 lbs./hr. each—465 lbs.
Great Western Sugar Co., Billings, Mont.
3—125,000 lbs./hr. each—160 lbs.
Godchaux Sugars, Reserve, La.
1—100,000 lbs./hr.—475 lbs.
U. S. Military Academy, West Point, N. Y.
2—100,000 lbs./hr. each—160 lbs.

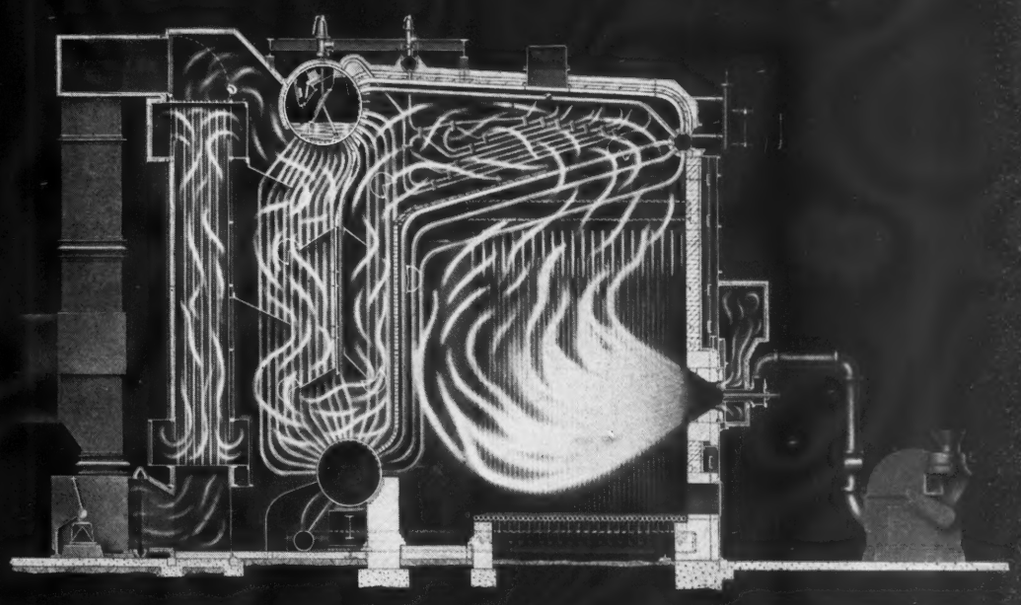
Riley "RP" Units

Guide Lamp Co., General Motors Corp., Anderson, Ind.
1—50,000 lbs./hr.—275 lbs.
Bemis Bag Co., Peoria, Ill.
1—70,000 lbs./hr.—275 lbs.
Newport Electric Co., Newport, R. I.
2—60,000 lbs./hr. each—275 lbs.
General Aniline Co., Rensselaer, N. Y.
1—80,000 lbs./hr.—250 lbs.
Riverside Metal Co., Riverside, N. J.
1—65,000 lbs./hr.—450 lbs.
Wheeling Steel Co., Wheeling, W. Va.
1—100,000 lbs./hr.—660 lbs.
Central Ohio Pr. & Lt. Co., Findlay, Ohio
2—60,000 lbs./hr. each—450 lbs.
Hartford City Paper Co., Hartford City, Ind.
1—55,000 lbs./hr.—350 lbs.
Lewiston Bleachery, Lewiston, Me.
1—70,000 lbs./hr.—450 lbs.
Hellwig Silk Dyeing Co., Philadelphia, Pa.
1—100,000 lbs./hr.—475 lbs.
Great Lakes Steel Corp., Ecorse, Mich.
2—75,000 lbs./hr. each—450 lbs.
Natrona Power & Light Co., Natrona, Pa.
1—90,000 lbs./hr. each—450 lbs.
S. J. Brisban Co., Colombia, S. America
1—36,000 lbs./hr.—425 lbs.
Winchester Repeating Arms Co., New Haven, Conn.
2—75,000 lbs./hr.—each725 lbs.
Western Cartridge Co., E. Alton, Ill.
2—75,000 lbs./hr. each—725 lbs.
American Bridge Co., Trenton, N. J.
2—35,000 lbs./hr. each—275 lbs.
Port Huron Sulphite & Paper Co., Port Huron, Mich.
1—80,000 lbs./hr.—675 lbs.
Barrett Co., Frankfort, Philadelphia, Pa.
1—80,000 lbs./hr.—450 lbs.

Riley "RO" Units

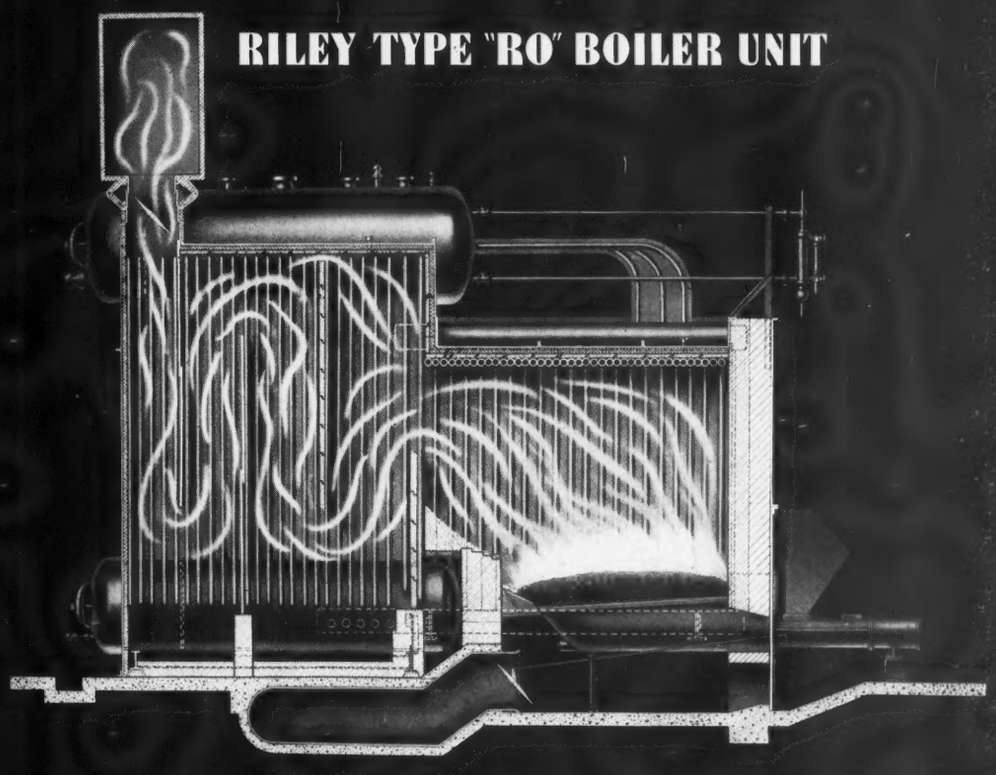
Pet Milk Co., Coldwater, Ohio
1—20,000 lbs./hr.
Pet Milk Co., Delta, Ohio
1—20,000 lbs./hr.
Pet Milk Co., Weyland, Mich.
1—20,000 lbs./hr.
Seneca Knitting Co., Seneca Falls, N. Y.
1—15,000 lbs./hr.
C. G. Conn Co., Elkhart, Ind.
1—30,000 lbs./hr.
Seegar Regfrigerating Co., St. Paul, Minn.
1—25,000 lbs./hr.
Hooker Paint & Glass Co., Chicago, Ill.
2—7,500 lbs./hr. each

RILEY TYPE "RP" BOILER UNIT



For Capacities between 40,000 and 150,000 lbs. per hour
THE RILEY TYPE "RP" STEAM GENERATING UNIT

RILEY TYPE "RO" BOILER UNIT



For Capacities between 7500 and 40,000 lbs. per hour
THE RILEY TYPE "RO" STEAM GENERATING UNIT

COMPLETE STEAM GENERATING UNIT

RILEY

STOKER CORPORATION
WORCESTER, MASSACHUSETTS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS - PULVERIZERS - BURNERS - STOKERS
WATER-COOLED FURNACES - STEEL CLAD SETTINGS

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit
Tacoma Baltimore St. Louis Cincinnati Houston Chicago
Milwaukee St. Paul Kansas City Los Angeles Atlanta New Orleans

PROPERTIES OF COMMON REFRIGERANTS

(from Air-Conditioning & Engineering, American Blower Corp.)

Name of Refrigerant Chemical Formula Trade Name	Ammonia $N H_3$		Carbon Dioxide $C O_2$		Dichlorodifluoromethane $C Cl_2 F_2$ F-12, Freon		Dichloroethylene $C_9 H_2 Cl_2$ Dielene		Dichloromethane $C H_2 Cl_2$ Carrene		Ethyl Chloride $C_2 H_5 Cl$		Methyl Chloride $C H_3 Cl$		Sulphur Dioxide $S O_2$	
Temperatures for Standard Ton Conditions	*86 F*	*5 F*	*86 F*	*5 F*	*86 F*	*5 F*	*86 F*	*5 F*	*86 F*	*5 F*	*86 F*	*5 F*	*86 F*	*5 F*	*86 F*	*5 F*
Pressure, lb abs	169.2	34.27	1039.0	334.4	107.9	26.61	6.9	0.82	10.6	1.17	27.10	4.65	95.53	20.89	66.45	11.81
Vapor volume, cu ft per lb	1.772	8.150	0.0474	0.2673	0.389	1.485	8.5	63.0	6.68	49.9	3.29	17.06	1.075	4.530	1.185	6.421
Liquid density, lb per cu ft	37.16	41.11	37.41	61.22	80.63	90.0	—	79.0	—	—	54.88	59.0	55.8	61.0	84.44	92.00
Heat of liquid, Btu per lb	138.9*	48.35	45.45***	−13.16	27.7*	9.32	23.2**	1.35	—	—	23.1***	−11.6	59.34*	21.19	42.12*	14.11
Latent heat, Btu per lb	492.6	565.0	27.00	115.30	59.65	69.47	113	136.0	143.0	162.0	162.6	177.0	162.09	178.50	142.80	169.38
Heat of vapor, Btu per lb	631.5	613.35	72.46	102.14	87.37	78.79	156.2	37.35	—		185.7	165.4	222.25	199.76	184.92	183.49
Entropy — liquid	0.2875	0.1092	0.0868	−0.0275	0.05708	0.02097	0.0425	0.0029	—		0.0445	0.0241	—		0.0878	0.0315
Entropy — evaporation	0.9029	1.2161	0.0495	0.2482	0.10932	0.14955	0.2435	0.293	—		0.2978	0.3807	—		0.2617	0.3645
Entropy — vapor	1.1904	1.3253	0.1363	0.2207	0.16640	0.17052	0.286	0.2959	—		0.3423	0.3566	—		0.3495	0.3961
Specific heat / constant pressure	0.79	0.91	0.2025		0.1476	0.1372	0.1625		0.154		0.273		0.24		0.511	
of vapor \ constant volume	0.4011		0.1558		0.1297	0.1190	0.1425		0.128		—		0.20		0.406	
Specific heat of liquid	1.10		—		0.243	0.214	0.27		0.34		—		—		—	
Critical pressure, lb abs	1651.0		1071.0		580.0		800.0		640.0		784.0		969.2		1141.5	
Critical temperature, F	271.2		87.80		233.0		470.0		421.0		361.0		289.6		314.8	
Molecular weight	17.031		44.0		120.9		96.9		84.9		64.497		50.481		64.065	
Boiling point, F, 1 atm	−28.0		−108.4		−21.7		122.0		105.0		53.96		−10.66		14.0	
Latent heat, Btu per lb, 1 atm	589.4		158.6		—		132.0		—		168.6		180.6		172.3	

* Above −40 F ** Above 0 F *** Above 32 F

Refrigerant properties are customarily given for "Standard-Ton" conditions at 86 F and 5 F. Evaporator temperatures in air conditioning are about 40 F, and evaporator pressures are proportionately higher than for 5 F.

Ammonia is the most common refrigerant for ice-making and cold-storage plants because of its high latent heat. It is little used for air conditioning because it is irritant and toxic even in small concentrations. Even though hazard can be reduced to a minimum by best construction, its use is prohibited in public buildings in some localities. Ammonia attacks copper alloys.

Freon is the refrigerant most widely used in air conditioning. It is non-toxic and non-irritant, but decomposes in the presence of flame into toxic products. It will not burn or explode. Special lubrication is required because Freon reacts with ordinary oils. Evaporator and condenser pressures are above atmospheric.

Carbon Dioxide requires high pressures for liquefaction (1000 lb) and therefore more expensive compressors and piping. Its advantage is perfect safety under all conditions; it will not burn or explode and is non-toxic and non-irritant. Maximum condenser temperature is 87.8 F, critical temperature. Compressor power is about 50% more than for other refrigerants.

Sulphur Dioxide is non-inflammable but highly irritant. Its principal use is in domestic refrigerators and unit room-coolers. It reacts with most lubricating oils and in the presence of water forms sulphurous acid which attacks most metals.

Ethyl Chloride is combustible and in some mixtures, explosive. Its uses are the same as sulphur dioxide.

Methyl Chloride does not readily explode nor is it easily ignited. Its uses are the same as sulphur dioxide.

Dielene and Carrene operate at pressures below atmospheric so that infiltration of air must be cared for. Their large specific volumes are an advantage for use with centrifugal compressors but they are not suited for piston compressors. They are not dangerously toxic in slight concentrations.

Water as a refrigerant requires evaporation under high vacuum. Only steam-jet booster compressors and specially-designed centrifugal compressors, run at high speed, are suitable. Its cheapness and safety are advantages.

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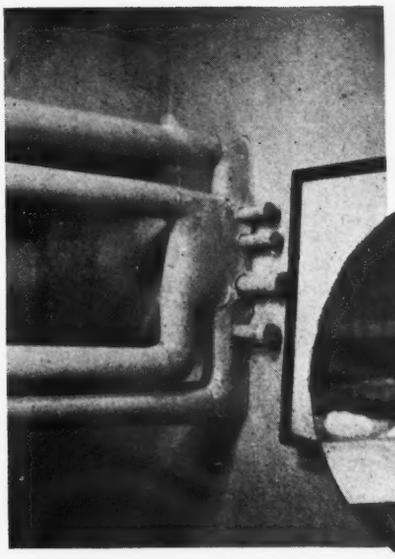


Fig. 1—Problem: How would you work on this piping?

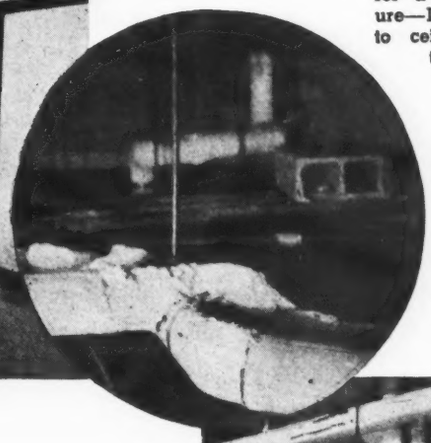


Fig. 2—Here's a place for a streamlined figure—18 in. from pipe to ceiling, less than that below

Designed for CONTORTIONISTS

An operating engineer commits his "who-in-the-heck-designed-this" thoughts to paper

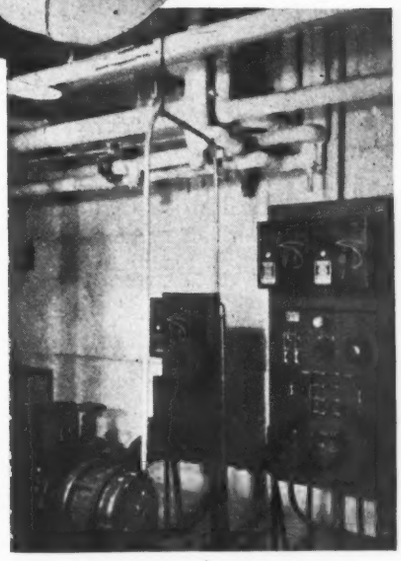


Fig. 3—Periodic baths for contactors are assured by locating riser cleanout plugs over panels

By Walter Thomas

HE HAS RUBBER ARMS, crackproof shins and a bump-proof head. He is small or tall as need requires. He works equally well upside down. He can see in the dark, doesn't mind infernal heat and positively likes an occasional unexpected shower of steam or boiling water. Who is he? Why, he's the operating engineer some designers seem to have in mind when they fill plants with equipment located in cramped corners, accessible only to a midget or contortionist.

All of which is an exaggerated way of saying that plant designers could greatly improve operation and maintenance of the plants that come from their drawing boards if they remembered that it's one thing to draw a picture, another to make it work. It requires no feat of memory to recall holding a man by his shoes while he worked with his head where his feet should be, on the anchor bolts of a failed sump pump.

The difficulty of access to the heating lines in Fig. 2 is obvious, nor is appreciation of the soundness of this heating-system layout increased by a glance at Fig. 3, showing the cleanout plugs for heels on risers directly over electric-control panels. In the prize exhibit, Fig. 1, piping is set so close to a wall that it was necessary to cut a portion of the bearing walls and foundation before anybody could get at it.

Treasured Memories

Every operating engineer treasures memories of piping systems characterized by inaccessibility, lack of fittings for ease of removal, improper pitch and generally poor layout. Many have had the experience of setting up elaborate rigging to replace lamps in lighting fixtures; many have watched maintenance men making awkward and hazardous climbs for the same purpose. And many will remember the frustrated feeling when it is discovered that no space has been allowed for removing a shaft or withdrawing the internals of equipment.

So much for cases. What is the cure? Actually there is no complete cure. The high cost of space puts a premium on compactness of design, with inevitable crampedness, and human failure to foresee all contingencies must be counted on. However, designers can help by visualizing operation and maintenance procedures for each item in a plant layout and allowing for them in the plans. The operating engineer is the man who knows these things; he should be consulted at each stage of the design. And finally, both designer and operator should follow the construction work closely to see that equipment is installed according to the approved layout, and that where details are left to the contractor, he uses good judgment. The resulting plant will cost no more, and real improvement in operation and maintenance will follow.

HARD FACING Pays Its Way

Stellite, a cobalt-chromium-tungsten alloy, one of several hard-facing materials for high-pressure, high-temperature steam, has reduced the cost of keeping valves tight

By E E LeVan

GENERAL SALES MGR, HAYNES STELLITE CO, KOKOMO, IND.

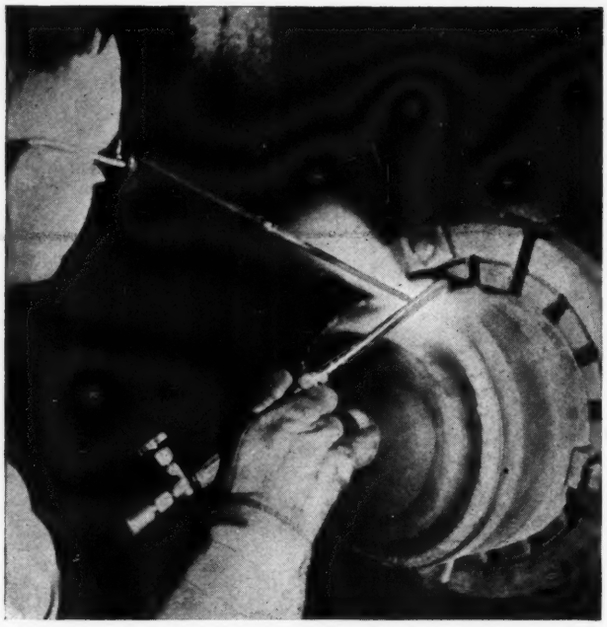


Fig. 1—Applying hard-facing material to a 9-in. steam-valve disk

FIVE YEARS AGO a well-known manufacturer of steam valves hopefully stated, in regard to the use of alloy trim on valves for high-temperature, high-pressure service, "Stellite has not had sufficient years of severe valve service to permit a permanent evaluation as yet, but it seems to have marked possibilities for service which involves wire drawing." A year later, in 1934, the same manufacturer observed, ". . . the use of hard-surfacing material to resist wear . . . is a valuable modern metallurgical development." Recently, this manufacturer has indicated his wholehearted support of protecting valve-seat surfaces in this manner.

A number of industrial power plants and large steam stations in cooperation with valve manufacturers have investigated hard-faced valves. Test installations have been made, and valve performance closely watched. The mass of performance and cost data which has been assembled has proved that valves with hard-faced seating surfaces are a most satisfactory and economical solution to one of the most pressing problems in handling high-pressure, high-temperature steam.

Beside the work of valve manufacturers, a most important contribution has been made in tests carried on by a large Midwestern generating station. At this plant, hard-faced valves were installed about five years ago, and the experience gained has been of material benefit to other industrial and utility power plants.

Large gate valves were among the first to which valve manufacturers applied hard-facing materials. High temperatures and pressures require that ordinary valves be reconditioned too often. In addition to reconditioning expenses, time is lost replacing the valves and shipping them back to the manufacturer. After repairs are made, they need to be reconditioned again after only a short period of service.

Hard-facing by valve manufacturers has several objectives: longer life, fewer shutdowns, and less cost to keep the valves tight. Gates and rings are machined to provide clean surfaces for hard-facing application; cobalt-chromium-tungsten alloy is flowed onto these surfaces by means of an oxy-acetylene blowpipe; and finally, the surfaces are ground to the desired finish.

Valves whose seating surfaces are hard-faced in this manner cost more initially than unfaced valves, but, since the hard-faced valves usually last several times as long as ordinary valves, and remain free from wire-drawing, hard-facing has been found thoroughly economical.

In a test at a large power plant, using a ¾-in. globe valve on a 460-lb superheated steam line, the hard-faced seat and disk were removed for inspection after 14 months continuous operation. The valve was tight, seating surfaces showing no indication of scoring or wire drawing. The test valve was used for drip service and formerly had to be replaced every two weeks. The valve lasted many times as long as formerly and after inspection, was put back in service.

At a 1200-lb plant in the South, hard-facing has increased the life of valves on a duplex boiler-feed pump. The life of ordinary valves was 500 hours after which replacement was necessary because of deep cuts on the valve seats. To obtain longer life, the valve seats, approximately 2 in. in diameter and ¼ in. thick, were redesigned in two sections and covered with a thin layer of Stellite. The hard-faced valves operated 5000 hours before reconditioning was necessary. Even then rebuilding was not necessary because of cuts on the valve seats, but because constant hammering had tended to mushroom the base metal. Study revealed that the use of a harder and tougher base metal and a

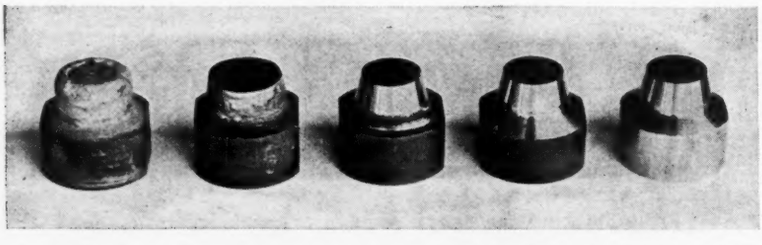


Fig. 2—Various stages in grinding a ¾-in. globe-valve disk. Left to right: after hard-facing, surface ground, seat rough-ground, shoulder and flat finished, finished

thicker alloy deposit would remedy the difficulty. The hard-faced seats increased the life ratio over steel by more than 10 to 1.

At still another power plant, hard-faced valves were installed in a 650-lb, 850-F steam line. Hard-faced valves also control the feed line at 1000-lb pressure and 350 F. So far, these valves have been in service for over 13,000 hours without repair or replacement. The slight extra cost of alloy-trimmed valves has been paid for many times over by their maintenance-free service.

Withstand Erosion

That hard-facing materials can withstand terrific erosion when handling water at high pressures and velocities is demonstrated by the fact that a number of hydroelectric stations have adopted hard-faced needles and nozzles in water turbines. These nozzles direct streams of water under heads of from 1400 to 2000 ft. The direction of the stream and the angle at which it impinges upon the blades of the wheel are carefully controlled to obtain maximum turbine efficiency. Erosion of either needle or nozzle diverts the stream from the most efficient angle and results in reduced output. Several tests have been made to determine the best material for this service.

In California, two power stations using high-head impulse wheels have replaced former equipment with hard-faced nozzles. At one installation with a water head of over 2200 ft, a throat ring 8½ in. in diameter discharges 216 cfs at full load of 33,000 kw. Changing the course of water traveling at 400 mph requires a material which can withstand terrific erosion. Stellite has proved effective, standing up under extreme treatment and reducing replacements and time lost for repairs.

Needles and nozzles formerly replaced every three months, now hard-faced, last two or three years without showing severe wear. A set of new parts costs about $250. The hard-facing operation costs $250 for labor and materials. When worn, the hard-faced set can be refaced repeatedly. Due to increased life of hard-faced parts, the power loss due to shutdown for replacement of valves has been reduced 90%. Hard-faced needles and nozzles eliminate one of the most important difficulties in plants where continuous operation is of paramount importance.

Steam and water-power stations are not the only ones to benefit from hard-faced controlling devices. Heavy-duty diesel valves and seats, when hard-faced, give efficient service longer. On a 900-hp diesel, using steel valves and cast iron valve seats, it was found necessary to regrind valves and seats every month. Twelve valves and several valve seats were hard-faced.

Several combinations of materials were used in the engine under identical operating conditions. After a month of operation when it was known that steel valves and cast iron seats would require attention, the other materials were also inspected. Hard-faced valves required no attention and the hard-faced seats were in excellent condition. After seven months, when the engine was dismantled, the hard-faced valves and hard-faced seats were lapped into one another.

The hard-facing process has been used for many other power plant applications, air-duct louvres, pulverizing mill plows, coke-handling machinery, and other parts subjected to abrasion. Failure of induced-draft-fan vanes caused trouble in a Lake Michigan plant. Fly ash eroded the vanes rapidly, especially near the bearings. The temperature is around 450 F, and the fly ash content high. Prior to the adoption of hard-surfacing treatment, vanes lasted 9 months and then were worn beyond repair. Worn blades were replaced with new ones at a cost of $10 each. Twelve fans have 42 vanes each; the expense involved is considerable.

Hard-facing alloy was welded on the contact surfaces in concentric arcs at the points of greatest wear, and also in straight lines where excessive wear showed. After a few experiments at placing the beads of alloy to insure maximum life, actual operating conditions soon indicated proper locations. The hard-surfaced blades have lasted several years and are expected to last several more. Hard-facing costs $4 a vane in addition to the cost of the new vane.

In addition to the money saving in vane replacement, it is estimated that about $100 an hour is lost when this equipment is out of service. $4800 is saved by every shut-down eliminated.

Another economy is effected by the use of hard-facing for various parts of the coal pulverizing mills at this plant. Eleven mills are installed but two can be taken out of service at a time under present operating conditions. Excessive wear on the yoke arm where it contacts the back of the pusher block has been reduced by hard-facing the surfaces where the yoke arms and pushers are bolted together.

Threatened replacement of the $1000 yoke due to wear on the coal plows was avoided by attaching angle irons vertically to the sides of the yokes, but these had a very short life. The maintenance department devised plows to be attached to the bottom of the rotating yokes, which lasted not much longer. Hard-facing material on the bottom edges of the plows has resulted in a 2-year life.

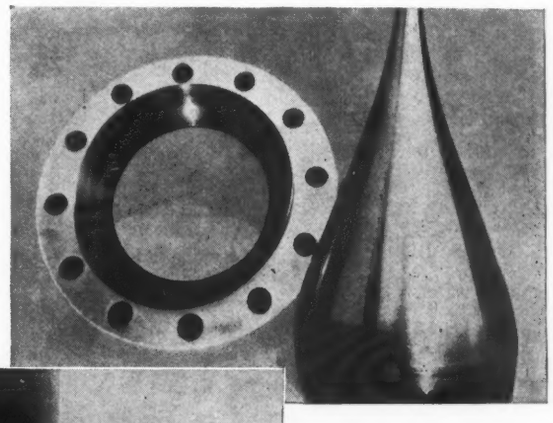
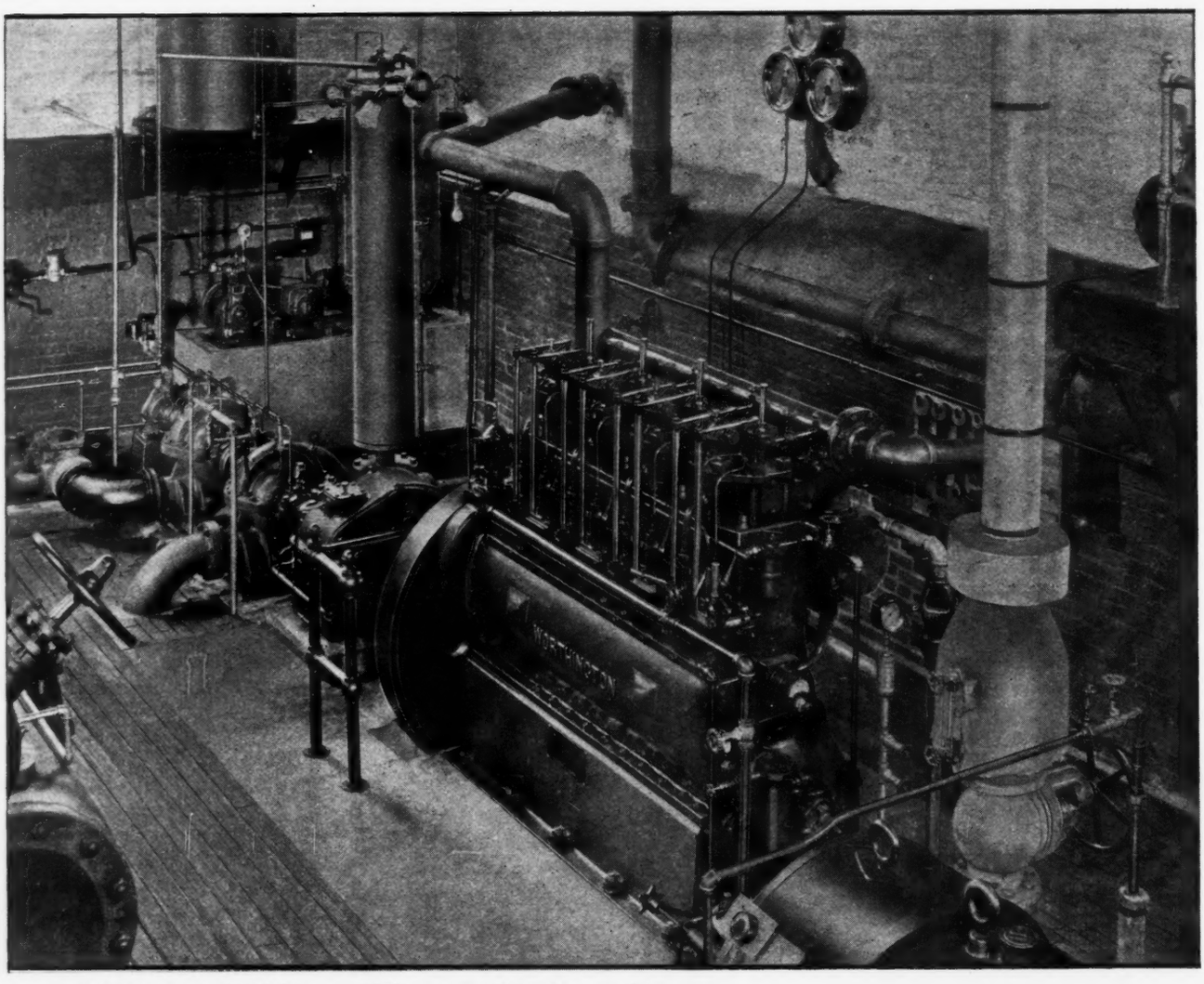


Fig. 4 — Hard-finished needle valve and seat ring

Fig. 3 — A 5-in. diesel valve, hard-faced with Stellite, after seven months continuous service in a 900-hp marine engine



Milford's newest diesel drives an 1800-rpm pump through a speed increaser. This is a 180-hp unit; the two earlier ones were 100 and 125 hp

Diesel-Pumping Bay State Water

Milford and Foxboro, Mass., have recently replaced obsolete steam-driven pumping units with dieselized pumps. Milford reports savings of $7, Foxboro $15, per million gallons

By
Francis A Westbrook

SEVERAL MASSACHUSETTS communities have recently installed diesel-driven municipal pumping plants. That at Townsend was described recently in *Power* (December, 1937, page 781); Milford and Foxboro are two of the others, being similar in that both replaced obsolete steam-driven equipment with diesels.

Milford Water Co now has three diesels, 100, 125 and 180 hp, the first and smallest installed in 1934, the second in 1935 and the latest and largest just recently. Previous to 1934, all pumping was by steam engines and turbines, the last turbine being replaced by the newest diesel.

In 1934, Milford found that its pumping cost had risen from the original $10 to almost $13 per million gallons. The final decision was to try one diesel unit, so a 4-cyl, 8x10½-in., 514-rpm, Worthington diesel was installed, driving an 1800-rpm centrifugal pump through a Farrell-Birmingham speed increaser. The engine is rated at 100 hp; pump capacity is 1,000,000 gal. per 8-hr day, about Milford's total normal requirements.

Total pumping head is 265 ft normally, rising to a maximum of 286 ft, which includes a suction lift of 15 to 16 ft (normal), up to 20 to 22 ft (max.). The high-duty steam pump had, in best operating condition, averaged $10; the diesel averages $6.

Milford's second diesel followed the next year, planned as a standby and fire unit. It is a 5-cyl, 125-hp Worthington. The third is a 6-cyl, 180 hp Worthington, designed primarily to provide an extra engine for fire service even when one unit is down for repairs, as well as a wide range of capacities to meet any operating condition.

Control on all units is manual, because an operator is constantly on duty. Usually, no engine is operated between 10 PM and 5 AM. Engines are started, as water-main pressure drops off, by compressed air supplied from a 2-hp Worthington motor-driven compressor, with a duplicate gasoline-engine unit for standby. Fuel is supplied from an outside subterranean 10,000-gal. tank. It flows by gravity into the building, then is pumped by hand through a Worthington fuel-oil meter to the day tank. Average fuel consumption is 95 gal. per 1,000,000 gal. of water delivered to the mains, or 35.8 gal. of fuel per million gal. of water per 100 ft of head.

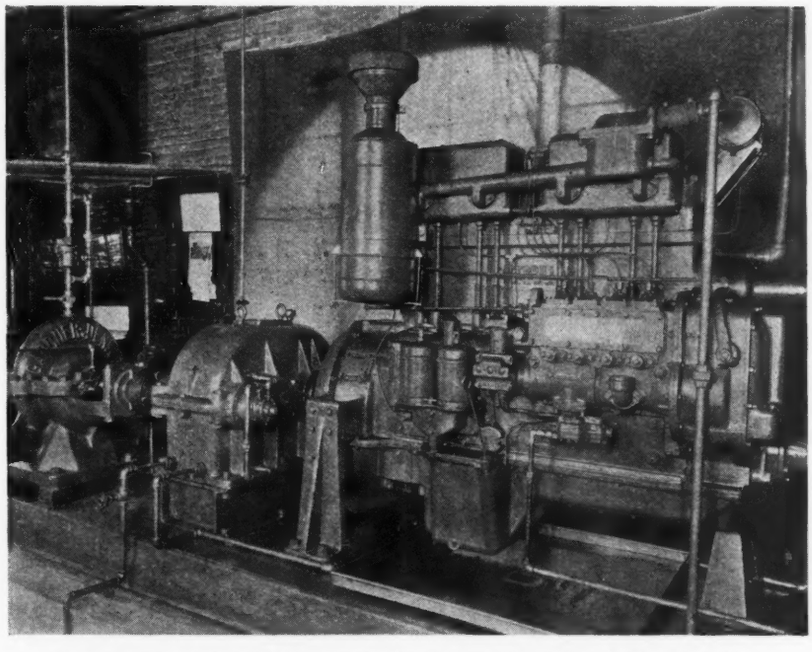
Lubricating oil, including regular changing and flushing of crankcases, averages 0.615 gal. per million gal. of water delivered.

Interesting in this plant is the method of keeping air out of the suction line. A miniature standpipe (see photo) is mounted on a tee in the suction pipe. A Nash Hytor air pump is direct-coupled at the end of the pumpshaft. Air drawn through the suction line accumulates in the top of the standpipe, forcing water level down. At a predetermined level, this drop actuates a Mercoid switch connected with a solenoid valve in the air-pump suction line. This connects the air pump to the top of the standpipe, and air is removed until the rising water level causes the switch to operate the valve and open the air-pump suction line to atmosphere.

Foxboro Has Dual Plant

Foxboro's old steam-engine-driven pump cost $22 to $24 per million gal. of water pumped, so the town engineer felt that something must be done. He therefore installed a diesel-driven unit which costs only $8 per million gal. to operate. The diesel is a 4-cyl, 4-cycle, 60 hp, 5¾x8-in., 850-rpm, Caterpillar, direct-connected through a Foote speed increaser to a 5-in., 1500-rpm, Gardner-Denver, double-suction, 54,000-gph, centrifugal pump, operating against an average head of 170 ft. Efficiency ranges from 12,800 gal. to 13,675 gal. of water pumped per gal. of fuel, the latter figure being obtained during a dry month when the engine was in operation a greater amount of time.

Fuel oil costs 5¾ cents per gal., lubricating oil 70 cents (5 gal. per 100 hr) giving a fuel and lube-oil cost of $6 per million gal., or $8 including repairs, insurance and attendance. A duplicate electrical unit, with 2-cent power, shows a cost of $18.30 per million gal. pumped.



At Foxboro, this diesel-driven centrifugal is paired with a duplicate motor-driven pump. Fuel and lube-oil costs are $6, total operating costs $8, per million gallons pumped

Motor Maintenance Costs

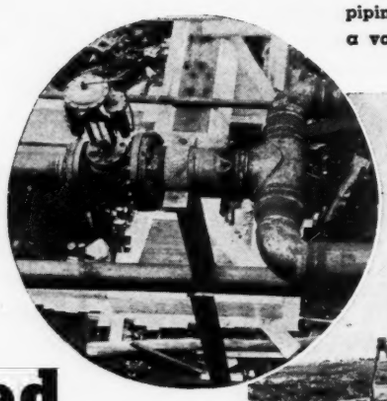
THE CHIEF of a large plant told us recently that he thought his dc-motor maintenance cost, $2.65 per hp per year, was a little high. Checking up, we found two other sets of figures, both for ac motors. Here they are:

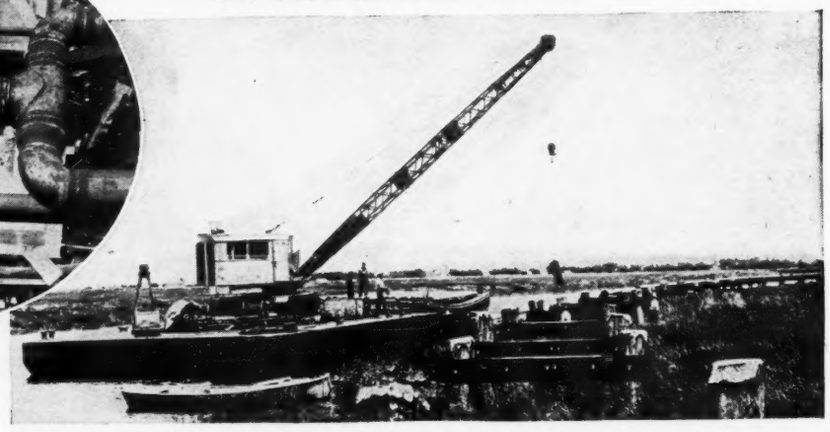
Plant No. 1—1045 motors total 7037 connected hp, of which 547 are fractional-hp units. In 1936, maintenance labor cost $4852 and materials $2891, a total of $7743 (including maintenance of starters and fuse boxes), making a unit cost per motor per hp per year of about $1.10.

Plant No. 2—1026 motors totalling 12,029 hp, of which 999 motors totalling 10,356 hp, or 86% of total connected hp, are usually in operation. Maintenance costs for 1935 were $6518.11 for motors, $516.39 for starters and switches, and $2042.34 for motor circuits, a total of $9078.84. Figures for the first 10½ months of 1936 were: For motors $5447.76, for starters and switches $2052.80, for motor circuits $429.69, a total of $7930.25. Compensating the 1936 figures to make them comparable to those of 1935, the maintenance cost per connected hp in 1935 was $0.755, in 1936 $0.744, and the maintenance cost per connected hp normally in operation in 1935 was $0.877, and in 1936 it was $0.865. These figures do not include $1500 per year for a motor oiler, but there is some question whether his wages should be charged to operation or maintenance. Such an allocation varies with the accounting system of the particular plant.

The above examples sound like fairly representative figures. If other readers have similar data, *Power* will be glad to publish them. Actual costs on any power equipment are extremely valuable to the man faced with a similar problem, as a comparison and guide if for no other reason. The only sound basis for judging the performance of a piece of equipment is a true and unbiased record of its first cost and operating expense. Unless such costs are available, plus some yardstick for comparison, only guesswork can govern. And a guess is just one step ahead of a headache.

Have any of you kept similar records? If so, send them in.





Water had to be brought 10 miles from the Mississippi in piping supported on trestles (below). A number of welds and a variety of fittings were used on high-pressure steam lines. Photo (left) is just outside boiler room

Welded Highways for Steam · Water · Sulphur

By O B McLaughlan* MASTER MECHANIC, FREEPORT SULPHUR CO.

GRAND ECAILLE plant of Freeport Sulphur Co. is about 50 miles south of New Orleans in the low, swampy lands of the Mississippi Delta, so transportation of men and material must be entirely by means of boats and barges. A 10-mile canal connects Grande Ecaille with the slightly higher and firmer ground at Port Sulphur, on the west bank of the Mississippi River. Some settlement of piling-supported buildings and trestles was expected and also on account of the high pressures and temperatures of the fluids transported through the piping, welded steel construction appeared to be the preferable design.

The only source of the large quantities of fresh water required for sulphur mining was the Mississippi River. To convey this water 10 miles to the plant required a pipeline along the canal bank. This pipeline is elevated about 6 ft. above the ground and supported by piling trestles. From Port Sulphur to Grand Bayou, about 3 miles, the line consists of two 12-in. steel pipes lying parallel on the trestles. At the Bayou, an underground crossing was necessary, accomplished by welding the 1-in. lines into a header from which six 8-in. lines lead downward into the mud bottom of the canal. Valves on each 8-in. line at the headers permit shutting off of one or more lines for emergency repairs. On the opposite side of the Bayou, the six 8-in. lines are connected to one 14-in. line by means of another header. The single 14-in. line continues from this point to Grande Ecaille.

In fabrication, three 20-ft. lengths of pipe were welded together at Freeport, Texas, to form 60-ft. sections which were shipped by barge to Port Sulphur. Upon arrival, the pipe was machine-scraped and painted in one pass. Two of the previously welded 60-ft. sections were welded together, and the 120-ft. sections then moved by barge, and laid in position by a dragline machine on a steel barge. When all pipe was in position, one tacking crew aligned and tacked the entire line with the exception of the channel crossing. Three welding operators followed the tacking crew and worked from a barge, using specially constructed platforms. Tie-in welds were made by means of position welding similar to the "bell-hole" welds on buried pipe, but all other welds on this line were made by rolling the pipe.

Lindewelding, the backhand method, was used on all welds. On the 14-in. pipe, average time was about 20 min per weld, with about 20 min for moving the barge. This system permitted welding of approximately 4800 ft. of pipeline per day.

Crossings

In fabricating crossings, the 8-in. pipe was welded into sections long enough to span channels, usually being about 500 ft. Individual sections were closed with "bull plugs" and tested with a hydrostatic pressure of 1000 lb per sq in. Welds were covered with forged reinforcing rings, welded in place with a weld along each side and a weld at each end. The entire pipe was then wrapped with tar paper and treated with a preservative. Cast-iron anchor weights were bolted in place and the pipes picked up and lashed to four barges, which towed them into position and dropped them into place. With the crossing pipes in place, the "bull plugs" were cut out and final tie-in welds were made. This pipeline is equipped with sliding expansion joints every 1000 ft. and, with the exception of these joints, no leaks have occurred.

For lining up the pipe for tacking, a simple but efficient tool was developed by Freeport Sulphur Co. Among advantages of this implement are low cost, speed of handling pipe, portability, and simplicity of construction and operation.

Tube turns, forged fittings, and "high hub" flanges were used to make welded fabrication faster and more convenient. High-pressure steam and air lines were fabricated from seamless tubing, the joints being ripple welded, while low-pressure lines are ordinary lap-welded pipe. Most of the power-plant pipe welding was done by the ripple method, due to the fact that experienced backhand welders were not available. Due to the necessity of uninterrupted service on the hot-water system, three complete circuits were provided so that a shutdown is highly improbable.

When the piping was completed, a hydrostatic pressure of 500 lb. per sq in. was imposed on the system. Boilers were then fired up and steam at 200-lb turned into the lines, after which the lines were allowed to cool and condense the steam, creating a vacuum. In spite of the complicated piping system, and the other conditions which made welding difficult, only three leaks were discovered.

For various reasons, it was advisable to locate the power plant approximately a mile from the actual mining operations. Such an arrangement requires pipelines for conveying hot water, compressed air and steam from plant to field, and here also the pipelines were laid on timber trestles or bents. With the exception of the compressed-air line, which carries a working pressure of 600 lb per sq in. and is made of 4-in. extra-heavy galvanized pipe, all lines are made up of standard pipe, backhand welded. Because of the small diameter and the galvanized surface, the 4-in. line was ripple-welded. Steam and hot water lines have a working pressure of approximately 250 lb. per sq in. In those lines as many joints as possible were welded by rolling, tie-ins being made with the pipe in proper position.

Piping problems encountered in actual production of sulphur are many and varied. It is necessary to convey liquid sulphur from the wells to the relay station and from there to the vats directly, or to the purification plant and then to the vats. The sulphur is kept molten by steam heat supplied by either a steam jacket or an inner line.

*An abstract of a paper at the 38th Annual Convention, International Acetylene Assn, Birmingham, Ala, Nov 10–12, 1937.

On comparatively long sections of sulphur lines, a "gut line" or inner steam pipe is used to maintain the desired temperature. The "gut line" is usually 2-in. galvanized pipe joined by welding, and the outer pipe which carries the sulphur is 6-in. standard. No effort is made to keep the steam pipe centered in the larger pipe, but where it enters and leaves, packing glands prevent leakage of the sulphur and permit differences of expansion. Steam pressure of about 90 lb per sq in. is carried in the "gut line" to maintain the desired temperature, and the outer pipe is insulated to reduce heat radiation. Insulation is protected by a wrapping of tar paper lashed in place with wire. Any short sections, fittings, or other interruptions in the sulphur line are steam-jacketed to prevent freezing of the liquid. Some assemblies are rather complicated, involving irregular shapes and more than one size of pipe. Welding is especially applicable to such work.

The "booster lines", as the mine-water lines are commonly called, are 6-in. galvanized pipe with asbestos insulation, and a sheet-iron covering also galvanized. As booster lines have to be moved from one location to another, they are assembled with standard flanges welded to the ends of each joint of pipe. This method of assembly permits repeated use of the same pipe in various locations without cutting and re-welding each time the line is moved. All welds on the galvanized pipe and galvanized asbestos covering are given a coat of red lead to prevent corrosion.

In the sulphur-purification plant, most of the piping is welded, some of it being high-chromium stainless steel. No unusual features are necessary, except large-diameter turns which have to be made up in the shop.

THE ENGINEER'S BOOKSHELF

Lubrication

PRACTICE OF LUBRICATION (3rd Edition) *—By T. C. Thomsen. Published by McGraw-Hill Book Co, Inc, 330 West 42nd St, New York, N. Y. 638 pages, 6x9 in. 232 illustrations. Price $6.*

The third edition of this standard text is completely rewritten to include recent major developments in the science of lubrication. 20 pages of text and five illustrations have been added. Text is complete and uniformly readable, including European practice as well as American, with the language amazingly simple and practical for a book on such a complex subject. This was one of the important basic texts in preparation of the June, 1937, *Power* Special Section on "Lubrication", and was found extremely useful for methods of lubrication of all types of equipment, suggestions as to lubricant types, constituents of various commercial lubricants, etc.

Transformer Practice

TRANSFORMER PRINCIPLES AND PRACTICE (1937). *By J B Gibbs, Transformer Engineer, Westinghouse Electric & Mfg Co. Published by McGraw-Hill Book Co, 330 West 42nd St, New York, N. Y. 210 pages, 6x9 in., 191 illustrations, 12 tables. Price $2.50.*

Transformers, in general the simplest type of electric equipment, have been developed into a wide variety of forms. This book gives attention to many problems connected with single-phase, three-phase, constant-current instrument transformers, and auto-transformers. These include coils and core construction, cooling, temperature indicating, polarity of windings, ratio adjustment, transformer oil, and mechanical forces in transformer windings and testing. A wide variety of transformer connections are also presented, such as common connections of single transformers singly and in banks; three-phase transformers; parallel operation of transformers and phase transformations by 2-winding transformers and by auto-transformers. Other subjects covered include care and operation of transformers; relative cost of operating transformers as affected by their losses, regulation and reliability, and the solution of typical transformer problems.

The author has succeeded in presenting a wide variety of material on transformers in a concise and practical way so that it is useful to both engineers and those who have only a practical electrical training.

Armature Winding

ARMATURE WINDING (1938). *By David P Moreton, Carl H Dunlap and L R Drinkall. Published by American Technical Society, Drexel Ave & 58th St, Chicago, Ill.* 280 *pages,* 5½x8 *in.,* 246 *illustrations. Price $2.00.*

Even though the title of this book is "Armature Winding", it is a practical manual on the construction, winding and repair of ac and dc motors and generators, together with practical connection diagrams. The first two chapters describe the different types of ac generators and motors. The next three chapters cover dc armature construction and armature winding and repair of dc motors and generators. About 100 pages in the latter part of the book are devoted to winding of ac motors and the repair of ac motors and generators.

Throughout the treatment is practical and readily understood even by non-technical readers. The illustrations have been carefully chosen for this purpose, making the text well suited for industrial courses and home study.

Control Standards

NEMA INDUSTRIAL CONTROL STANDARDS (1937)*—Published by the National Electrical Manufacturers Assn, 155 E 44th St, New York, N. Y. 49 pages, 8 10½ in.; paper binding. Price 60c.*

These standards form a reference work of practical information on the manufacture, test and performance of industrial control equipment. Representing standardized practice in the United States, they assist in harmonizing practices in the industry, promote production economies and consequently benefit electric-motor and control users. The text is divided into standards applying to all control; resistors; contractors; brakes, solenoids, auto-transformers and reactors; ac controllers; dc controllers; general purpose and machine-tool control; printing-press control; mine-hoist control; magnetic control for steel-mill auxiliaries; magnetic control for overhead cranes; synchronous-motor control; guide to specification for building-equipment-control apparatus; and definitions. These standards will be found a practical reference for engineers and others who are concerned with control applications and related problems.

Transformers

NEMA INSTRUCTIONS FOR CARE AND OPERATION OF TRANSFORMERS (1937) *—Published by National Electrical Manufacturers Assn, 155 E 44th St, New York, N. Y. 15 pages, 8 x 10½ in., paper binding. Price 25c.*

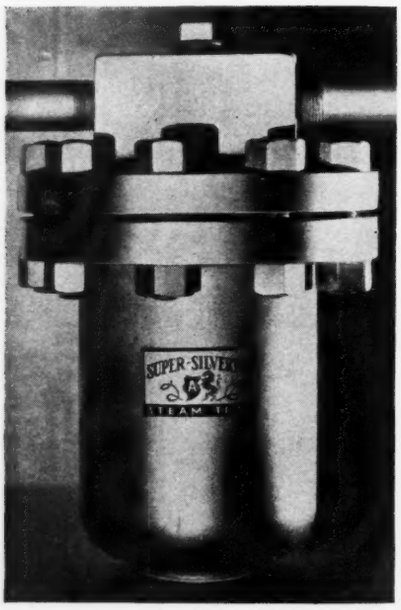
This booklet contains practical instructions for the proper care and operation of power and distribution transformers. As representing the recommendations of the Transformer Section of the National Electrical Manufacturers Assn, it will be found useful by engineers, electricians and other responsible for operation and maintenance of transformers. It supersedes the 5th edition issued April, 1931.

Mechanics

MECHANICS (1937)*—By William F Osgood. Published by The Macmillan Co, 60 Fifth Avenue, New York, N.Y. 495 pages, 5½ x 8½, 157 illustrations. Price* $5.

A mathematical treatment of the study of mechanics, Professor Osgood's text is intended for classroom use and requires a thorough working knowledge of calculus. Problems and exercises are particularly well chosen from simple everyday occurrences such as the motion of a billiard ball and the force equations of a crew shell in water. The exercises apply theory to practical problems in a manner that leads the student to a real and lasting understanding of the few fundamental laws.

WHAT'S NEW IN PLANT EQUIPMENT



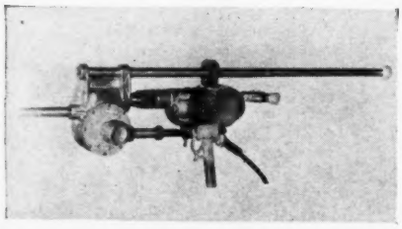
STEAM TRAP

"SUPER-SILVERTOP" bucket steam trap has case and head of forged steel. Recess gasket joints prevents gasket blowouts. Heat-treated-alloy head bolts, valve and seat of "Anderloy", a special chrome alloy. All other parts are of stainless steel. Incorporates features of regular models, but has 122% greater condensate capacity.

V D Anderson Co, 1935 W 96th St, Cleveland, Ohio.

POWER WRENCH

PORTABLE power wrench has worm-gear drive operated by any standard electric drill of ½-, ⅝- or ¾-in. size. Even pull and high starting torque make it applicable to winches, hoists, gates, valves, and



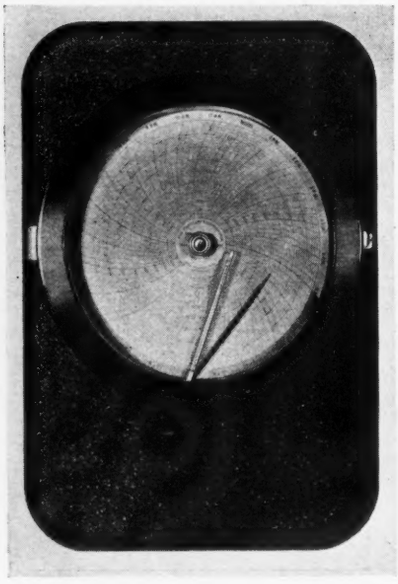
intermittently-operated machinery. Electric drill is rigidly clamped in place when operating wrench, but can be detached quickly when drill is needed for other work.

W C Lipe, Inc, Syracuse, N.Y.

TEMPERATURE CONTROLLERS

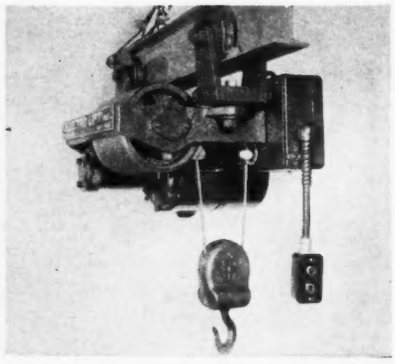
MODELS AR and ARF recording controllers, for temperatures up to 100 F, use sensitized paper and stylus for making permanent records on 10-in. round chart. Three types made: Red Top—normally on, 2-wire circuit control, capacity 500 watts ac, 50 watts dc; Green Top—normally off, 2-wire control circuit, capacity 500 watts ac, 50 watts dc; Blue Top—3-wire thermostatic control or single-pole, double-throw, capacity 200 watts ac, 25 watts dc. All elements interchangeable.

Partlow Corp, New Hartford, N.Y.



SMALL HOIST

"ROPE GUIDE HOIST" has drum with deep grooving, allowing cable to be completely submerged within grooves. Traveling guide has finger which runs in groove ahead of cable and holds it in its proper groove. Worm drive with



worm and wheel running on tapered roller bearing enclosed within gear case. Power load is carried on rigid cast-steel frame. Either rope or pushbutton control. Built in single- and double-hook types, sizes of ¼ to 5 tons.

Electro Lift, Inc, 30 Church St, New York, N.Y.

ACID-PROOF CEMENT

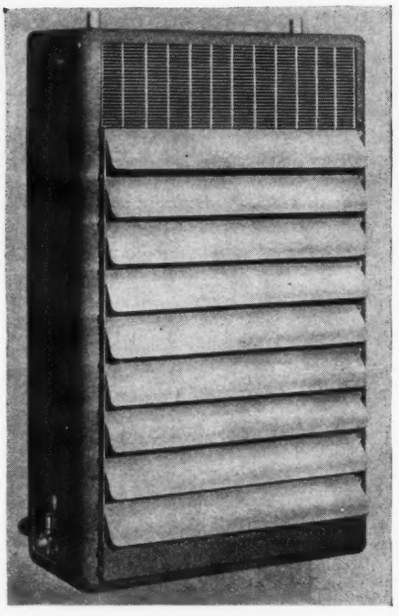
FOR chemical and metallurgical industries, public works and utilities, three acid-proof cements bond and repair masonry structures handling acid gas, fumes, vapors, acid solutions, etc. Grey cement withstands temperatures up to 2400 F; black and quick-setting black cements to 1200 F.

Quigley Co, 56 W 45th St, New York.

UNIT HEATER

STARTING fan motor closes electric circuit which operates solenoid gas valve to open gas burner wide and supply heat to unit. Current failure or overload shuts off current and gas valve simultaneously. Heater is vented to take off products of combustion. Fan and motor, mounted at rear, pass stream of air through heating element. Adjustable aluminum louvres.

Resnor Mfg Co, Thompson St, Mercer, Pa.



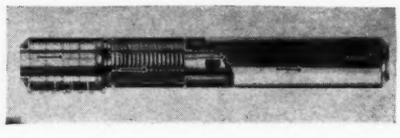
PROTECTIVE PAINT

"METLEAF" paint has leafed metallic-lead pigment. For surface protection of wood, metal, galvanized iron and concrete. Is mixed with vehicle, applied by brush or spray gun, and dries to thin sheet of metallic lead. Made in four grades for conditions of different severity.

Densol Paint Co, Rockside Rd, South Park, Ohio.

INDUSTRIAL MUFFLER

RMF SERIES mufflers, for internal-combustion engines, blowers and compressors, has 60% or more silencing volume

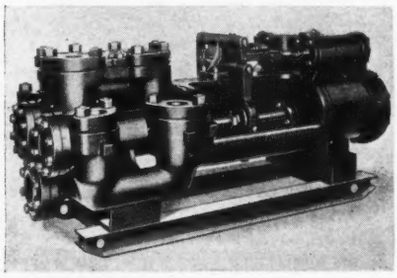


than standard Burgess heavy-duty muffler. Patented acoustic lining permits straight-through construction. Extra-heavy-gage sheet steel withstands corrosive action of hot gas. Drain holes at both ends remove condensate, oil and sludge. Hand holes facilitate inspection and removal of sound-absorbing pads for cleaning. Bulletin 330.

Burgess Battery Co, Acoustic Div, 111 W Monroe St, Chicago, Ill.

DUPLEX STEAM PUMP

FOR oil, water and other free-flowing liquids at high temperatures. 8-cover, side-pot fluid end permits easy servicing. Each suction and discharge valve is in its own valve pot and is easily accessible through single valve-pot cover. Steam and fluid ends are sealed by packing in deep stuffing box fitted



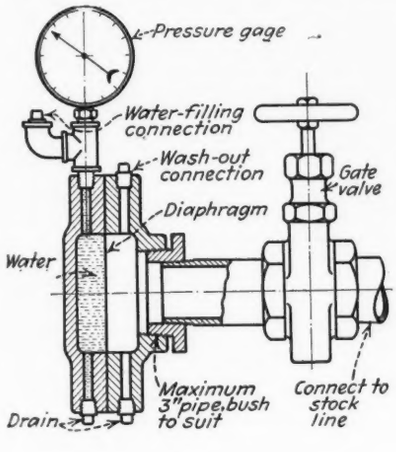
with removable bolted gland. Cradle between steam and fluid ends is long enough to permit access to both stuffing boxes. Capacities up to 148 gpm and fluid-end pressures up to 1000 lb per sq. in. Bulletin 6185.

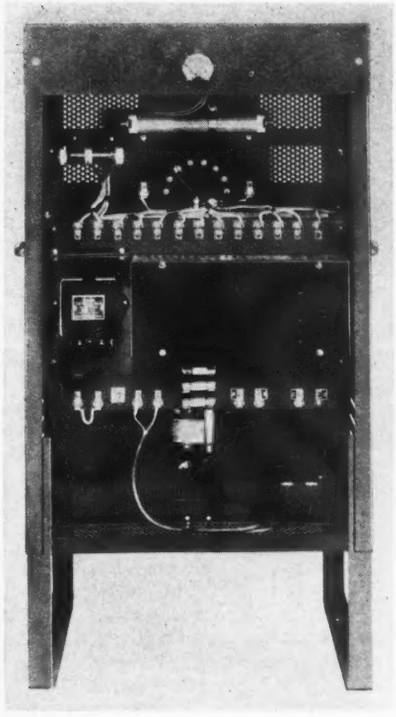
Fairbanks, Morse & Co, 900 S Wabash, Chicago, Ill.

DIAPHRAGM-GAGE CONNECTION

FOR handling paper stock or other liquids containing fibrous materials, this gage connection consists of two recessed circular flanges with thin flexible diaphragm between them. One flange is tapped for 3-in. pipe connection, and can be attached through nipples and gate valve to stockline or other pipe. When gate valve is opened, pressure of stock or other fibrous material acts on one side of diaphragm, which transmits pressure to water on other side.

Goulds Pumps, Inc, Seneca Falls, N.Y.





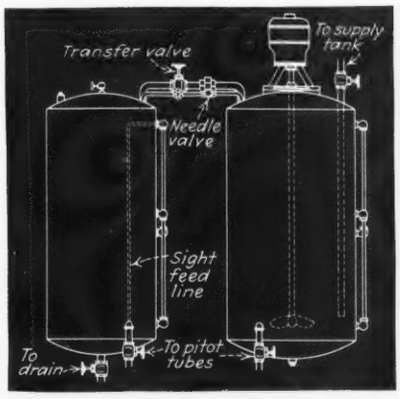
BATTERY CHARGER

AUTOMATIC charger for batteries used for control bus (oil switch operation, emergency lighting, etc), consists of fan-cooled cooper-oxide rectifier controlled by Exide TVR relay, an accurate electro-magnetic contacting device, self-compensating for ambient temperature variations. Through synchronous time switch, rectifier automatically puts battery on charge at definite intervals, usually once every hour.

Electric Storage Battery Co, Allegheny Ave & 19th St, Philadelphia, Pa.

PROPORTIONING UNITS

Two models, WW and S. First is standard Model B feeder with automatic recharge. Model S, illustrated, is automatic proportioner for continuous introduction of lime and similar suspended chemicals. Agitator in reagent



compartment does not emulsify oil. Similar to Model B, except that sight-feed indication is provided to keep reagent tank clear for agitation. Sight feed is indicated by water dropping through oil.

D W Haering & Co, Inc, 3408 Monroe St, Chicago, Ill.

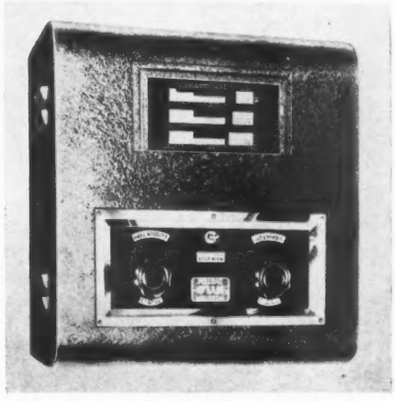
ASBESTOS PACKING

TYPE 72 compressed-asbestos sheet packing is addition to regular line. For temperatures above 212 F where gaskets are in contact with oil or solvent vapors. Is black in color with graphite mixed throughout.

B F Goodrich Co, Akron, Ohio.

HEATING CONTROL

"HYLO Steam Variator Control" delivers steam continuously to all radiators, keeps them fractionally filled when less heat is desired. By setting dial for prevailing outdoor temperature once or twice a day, operator supplies correct amount of heat to all radiators. Variator dial, when advanced, provides for rapid heating-up. Retarded, it adjusts steam supply for night heating. Can be applied where low-pressure steam,



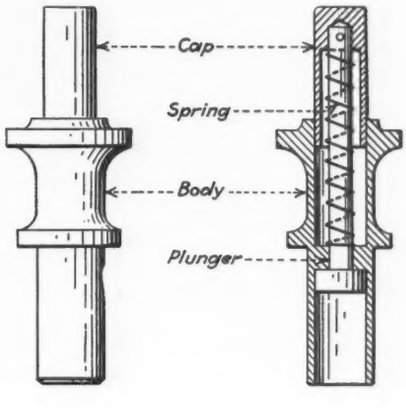
either vapor or vacuum, is circulated through 2-pipe orifice systems. With modifications, can control directly stokers or blowers and motor-operated draft dampers on hand-fired boilers.

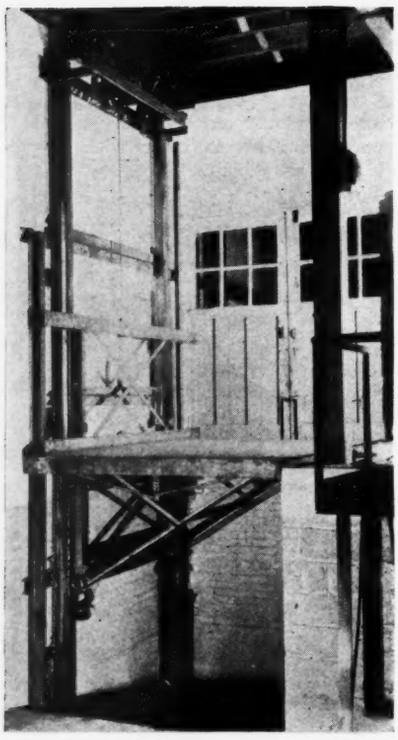
Warren Webster & Co, 17th & Federal Sts, Camden, N.J.

FITTING FOR EXPANSION JOINTS

"YARWAY PAK-AID" fitting facilitates insertion of new packing in Yarway "Gun-Pakt" expansion joints without removing packing-gun cylinders. Unit fits into cylinder of packing gun after gun plunger has been removed. By pushing down on plunger, new packing is forced into stuffing-box space.

Yarnall-Waring Co, Chestnut Hill, Philadelphia, Pa.





FREIGHT ELEVATOR

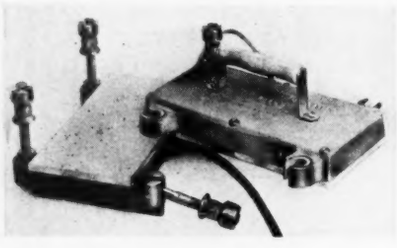
"WALLCLIMBER" for 1-story service, lifts up to about 12 ft. Guides and supports can be removed and set up in new location of similar dimensions. Capacities up to 5000 lb, and car sizes to 7x10 ft. Rails, cables, anchorage and counterweights are placed along one side only, while elevator machinery is overhead. Instantaneous self-aligning safeties act in event of cable breakage.

Revolvator Co, North Bergen, N. J.

BELTING VULCANIZER

BOTH upper and lower platens are heated. In operation, upper platen is swung edgewise off from lower one, single permanent bolt acting as axis. Then lapped ends of belt, with cement applied, are laid on lower platen. Upper platen is then swung back into position, and clamping pressure applied by four nuts. Either ac or dc; for either "Ton-Tex", fabric or rubber belts. Capacity is 7-in. belts in one operation, or 10-in. belts in two operations. Total weight 36½ lb.

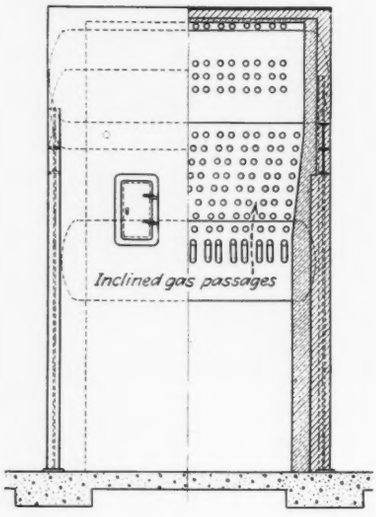
Ton-Tex Corp, 129 W 22nd St, New York, N.Y.



WATER-TUBE BOILER

NEW design of 3-drum, low-head, bent-tube boiler features spacing tubes along inclined gas passages. Patent is applied for tube arrangement, which exposes all tubes to gas in partial staggered spacing. Manufacturer claims 26% more direct gas wash of tubes, which means greater turbulence and therefore better heat transfer.

Page Boiler Co, Chicago, Ill.



WELDING HOSE

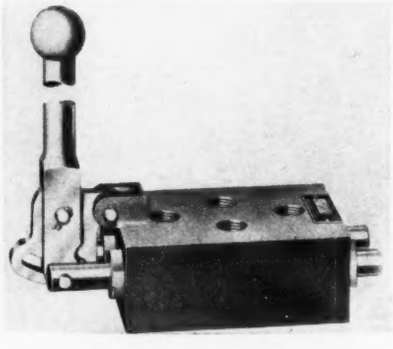
WILL resist action of molten metal or accidental exposure to torch flame long enough to permit operator to reach place of safety. Combines fire-resisting compounds with fabric and asbestos in-

sulation, non-kinking carcass will not flatten permanently, and tube will not flake off and clog welding head.

Goodyear Tire & Rubber Co, Inc, Akron, Ohio.

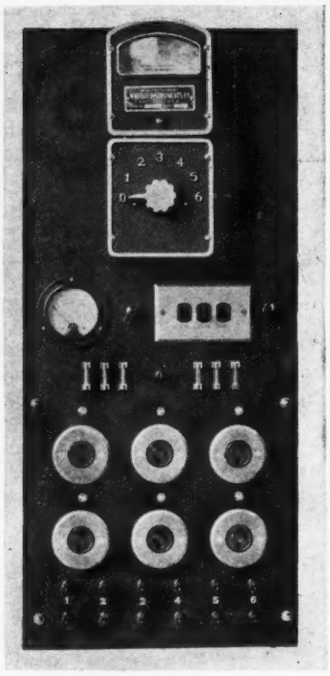
HYDRAULIC VALVE

MACHINED from solid steel slab for 1000- and 2000-lb working pressures. Made in 2-, 3- and 4-way types; latter two have only two internal parts for valving action to eliminate metal-to-metal wear. Piping connection may be



made either above or below. Entire valving assembly and cylinder or leverage can be removed and replaced in a few minutes. Piping connection need not be disturbed for inspection.

C B Hunt & Sons, Salem, Ohio.



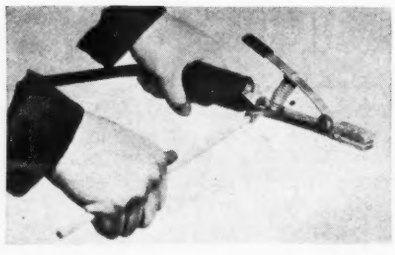
TEST PANEL

FOR small electrical equipment, this device tests internal or surface temperature up to 800 F, resistance from 0 to 1000 ohms; makes continuity current readings on milliameter as low as 10 milliamps. Also indicates current flow, tests for shorts, permits visual observation of thermostats, etc.

Wheelco Instruments Co, 1929 S Halsted St, Chicago, Ill.

ELECTRODE HOLDER

LIGHTWEIGHT arc-welding electrode holder weighs 14 oz and has current capacity of 250 amp continuous. All contacts electrically welded. Easily operated clamp locks cable to electrode holder. Clamp can be tightened or



loosened without tools by inserting welding electrode through square head of clamp cap screw and applying pressure.

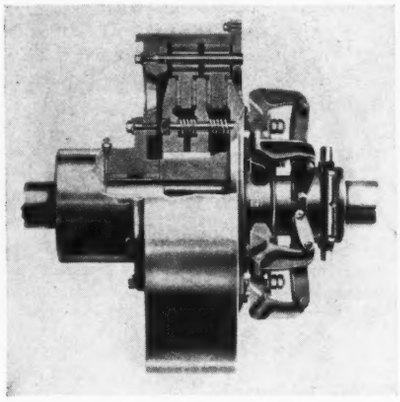
Lincoln Electric Co, Cleveland, Ohio.

AIR-LINE FREEZE PREVENTATIVE

"FROSTO" is vaporized and fed into compressed-air line near compressor as fast as necessary to prevent freezing of water vapor in lines and tools. For industrial applications or wherever electric current is available for operation of vaporizer. Only about one quart is

required to treat 100,000 cu ft of free air under worst conditions of temperature and humidity.

Sullivan Machinery Co, Michigan City, Ind.



FRICTION CLUTCH

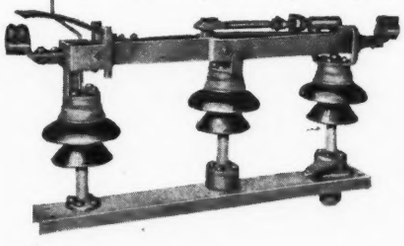
FOR oil, gas and diesel-engine drives, or on drives where heavy impact is encountered at either end. Disks are driven by steel pins, cushioned by rubber bushings. These bushings have special self-lubricating bronze bushings on inside of the rubber, so disks slide freely on steel pins. Combines features of friction clutch and flexible coupling.

T B Wood's Sons Co, Chambersburgh, Pa.

AIR-BREAK SWITCH

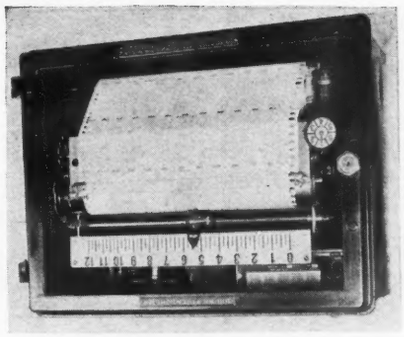
MODEL 8400 air-break switch has as basic principle changing a parallelogram whose angles are other than 90 deg to a rectangle. In changing blade parallelogram into rectangle, one blade travels backward while other blade travels forward, first wiping off contact surfaces. Powerful toggle mechanism, actuated by rear rotating insulator, sets up high-pressure contacts. This mechanism passes center in its final movement, securely locking blades in position. 7.5 to 69 kilovolts; 400 to 1200 amp.

Electrical Engineers Equipment Co, Melrose, Park, Ill.



MULTIPLE RECORDING POTENTIOMETER PYROMETER

MULTIPLE potentiometer records in multi-color and numerals. One symbol, plus (+) sign, is used; vertical line of sign identifies temperature and horizontal line the time coordinate. Intersection of two lines locates exact time-temperature record. 12-in. chart and number-print wheel make it possible to continu-



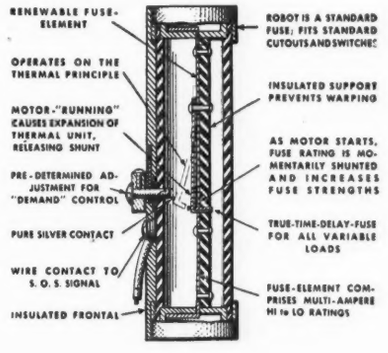
ously record from two to six temperatures from as many different thermocouples.

Brown Instrument Co, Philadelphia, Pa.

FUSES

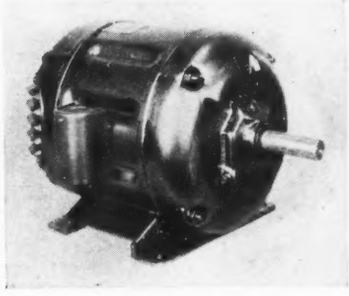
Two "Robot" fuses: "Floating Power" fuse protects motors against momentary abnormal starting currents, reduced normal running currents, and variable load requirements. "SOS" fuse, in combination with first fuse element and signal pilot, automatically signals overload, peak loads, and approximate demand of light and power circuits.

Champion Electric Fuse Co, 684 Broadway, New York, N.Y.


RENEWABLE FUSE-ELEMENT
OPERATES ON THE THERMAL PRINCIPLE
MOTOR-"RUNNING" CAUSES EXPANSION OF THERMAL UNIT, RELEASING SHUNT
PRE-DETERMINED ADJUSTMENT FOR "DEMAND" CONTROL
PURE SILVER CONTACT
WIRE CONTACT TO S. O. S. SIGNAL
INSULATED FRONTAL
ROBOT IS A STANDARD FUSE; FITS STANDARD CUTOUTS AND SWITCHES
INSULATED SUPPORT PREVENTS WARPING
AS MOTOR STARTS, FUSE RATING IS MOMENTARILY SHUNTED AND INCREASES FUSE STRENGTHS
TRUE-TIME-DELAY-FUSE FOR ALL VARIABLE LOADS
FUSE-ELEMENT COMPRISES MULTI-AMPERE HI to LO RATINGS

SINGLE-PHASE MOTOR

TYPE RG integral-horsepower, repulsion-induction, single-phase motor has electrical characteristics suitable for operating air compressors, viscous-liquid pumps, refrigerant compressors, conveyors, etc. Salient features are: high

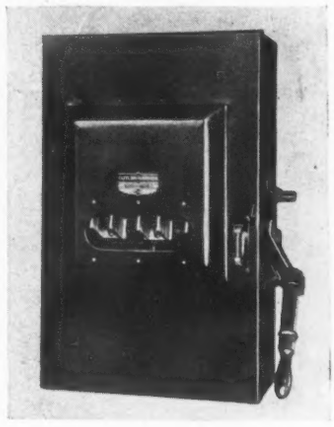


starting torque, low starting current, positive starting on low voltage, high power factor, and good efficiency. Made in sizes 1 to 3 hp, both vertical and horizontal.

Wagner Electric Corp, 6400 Plymouth Ave, St. Louis, Mo.

SAFETY SWITCH

MILL-DUTY safety switch has 3/16-in., shatter-proof glass window and sponge-rubber gasket to cushion glass and seal



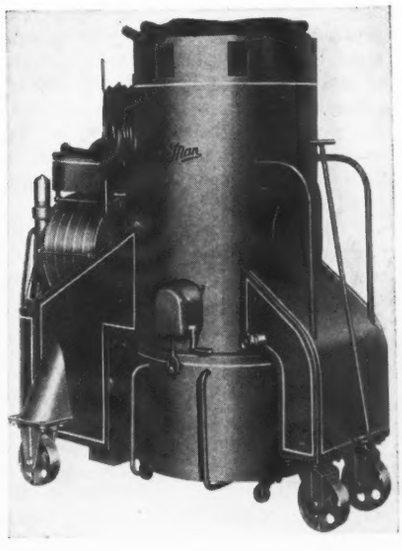
opening in cover. Quick make and break, pressure-type fuse clamps, non-current-carrying fuse posts, double-break air-blanketed contacts, silver-plated blades and jaws, unit-pole construction, and interlocked cover. Sizes from 30 to 1200 amps, 600 volts, fusible and non fusible.

Cutler-Hammer Inc, Milwaukee, Wis.

ARC WELDER

200-amp gasoline-engine-driven arc welder is mounted on steel skids and has complete canopy enclosure with hinged side panels that fold up over and can be padlocked when closed. Accessory equipment includes electric self-starter, battery ignition with generator, built-in fuel pump, air filter, variable-speed governor, radiator, and built-in fuel tank.

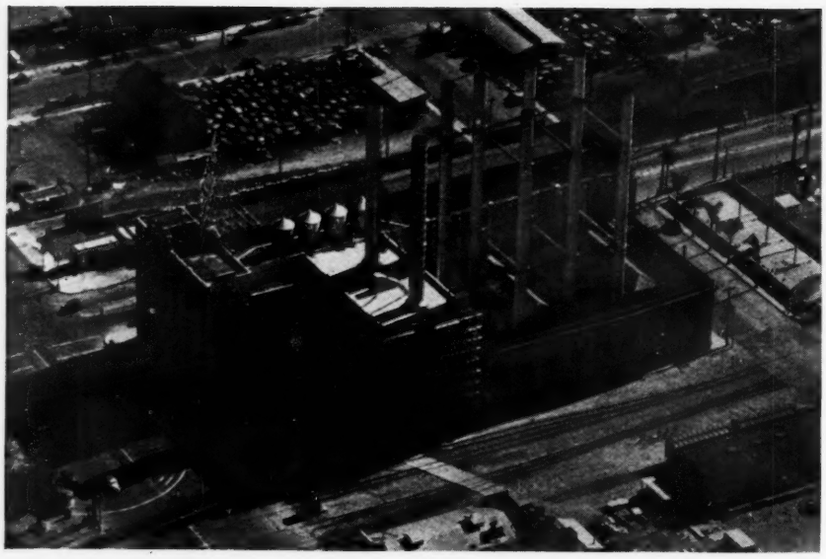
Hobart Bros, Troy, N. Y.



VACUUM-CLEANING UNIT

PORTABLE unit has large-capacity dust collector. Dust container has raising and lowering device actuated by crank handle. Unit has carrying space for cleaning tools and accessories.

U S Hoffman Machinery Corp, Air Appliance Div, 105 4th Ave., New York.



SAN DIEGO ADDITION

Aerial view of Station B of San Diego Consolidated Gas & Electric Co shows recently added 6-story white-roofed boiler room with its two-9 ft diameter stacks

POWER LINES

Hydroelectric Capacity Increases in Canada

A survey of hydroelectric progress in Canada during the past year shows that a renewal of hydroelectric construction is taking place throughout the Dominion. Mining and other industrial activities have created a growing demand for power as indicated by the monthly figures of output of central stations compiled by the Dominion Bureau of Statics. Each month in 1937 has shown a substantial increase over the corresponding month in 1936, and for the ten-month period January-October, 1937, an aggregate increase of more than 9% over 1936 is reported.

This growth in power demand has effected a substantial reduction of the reserves of installed generating capacity which have existed in certain parts of the country as a result of the construction program initiated prior to 1930. The industry is now directing its attention to the need of extending existing plants or undertaking new developments to meet the increasing requirements of industrial and domestic users.

New water-power installations in 1937 reached a net total of 167,161 hp, bringing the total for the Dominion at the end of last year to 8,112,751 hp. The larger new developments were those of Ontario Paper Co on Outardes river in Quebec, where an installation of 70,000 hp was completed, and the Great Lakes Power Co, which brought into operation a 10,000-hp installation on Montreal river in Ontario. The remainder of the increase was made up for the most part by extensions to existing stations. The 1937 increase was distributed by provinces as follows: British Columbia, 1,050 hp; Saskatchewan, 19,000 hp; Manitoba, 12,500 hp; Ontario, 15,475 hp; Quebec, 116,366 hp, and Nova Scotia, 2,770 hp.

Plan Engineering Meetings for San Francisco in 1939

The four founder societies (ASME, ASCE, AIEE, AIMME) are planning to hold concurrent conventions in San Francisco during 1939 in connection with the Golden Gate Exposition to be held that year. Negotiations are under way toward setting a date for the concurrent conventions and tentative agreement has been reached upon the week of July 10, 1939.

More Hydro Power for Central Maine

Central Maine Power Co is carrying on cofferdam and under-water preliminary work on the Kennebec River at Solon in connection with a proposed 7000-kw hydroelectric development designed to improve water control in the Bingham-Solon area. Estimated cost of the work now being done is $390,000, and the probable additional cost of installing one 7000-kw unit and completing the dam and head works is about $1,000,000.

The decision to finish the plant during 1938 hinges upon the trend of business by April, and as yet no contract has been placed for the generating unit. The improvement of the hydraulic conditions at Solon will be of great advantage to the power company in allowing it to vary the flow at the Bingham plant, which has an ultimate capacity of about 80,000 kva, two units having been initially installed. This will straighten out the flow at Solon, regulating it to a 24-hr basis and preventing interference with the mills below.

The company has been constructing hinged flashboards at its Gulf Island station dam, to raise the working head 3.5 ft in times of ordinary flow, or to a maximum of about 58 ft. These boards will add about 350,000,000 cu ft to the capacity of the Gulf Island pond, giving a total storage at that development of about 700,000,000 cu ft.

WPA to Proceed With 61 Power Projects

Decisions of the U. S. Supreme Court upholding the Federal Emergency Administration of Public Works power program opened the way to proceed with 61 projects in 23 States, having an estimated total construction cost of $146,917,808, for which PWA has allotted $61,225,544 as loans and $38,412,408 as grants.

The list of projects, together with sums and kw capacity involved follow:

Location	Estimated cost	kw. capacity
ALABAMA		
Sheffield	$230,000	.....
Decatur	350,000	.....
Hartselle	60,000	.....
Russellville	125,454	.....
Guntersville	87,272	.....
Tarrant City	329,091	.....
Bessemer	1,238,182	.....
Courtland	29,000	.....
ARKANSAS		
Paragould	$200,000	1,000
CALIFORNIA		
Imperial I.D.	$2,760,000	14,250
IDAHO		
Coeur d'Alene	$729,000	1,500
ILLINOIS		
Centralia	$477,000	2,000
Jacksonville	420,000	2,000
IOWA		
Lamoni	$97,000	400
Hopkinton	56,000	260
KANSAS		
Hoisington	$150,000	670
KENTUCKY		
Middlesboro	$328,000	1,280
MICHIGAN		
Bessemer	$187,500	600
Menominee	803,000	3,200
Dowagiac	202,000	900
MINNESOTA		
Glenwood	$150,909	600
Eveleth	845,000	2,500
Janesville	105,455	450

MISSISSIPPI		
Starkville	$150,909	.....
Aberdeen	120,000	.....
MISSOURI		
Trenton	$315,000	1,300
La Plata.....	100,000	400
Thayer	71,735	280
NEBRASKA		
Platte Valley...	$10,165,000	25,000
Loup River....	8,700,000	47,700
Tri-County	30,096,000	52,000
Columbus	400,000	.....
NEVADA		
Las Vegas.....	$250,909	.....
NEW YORK		
New Hyde Park	$300,000	1,400
Plattsburg	520,000	1,800
NORTH CAROLINA		
High Point ...	$5,766,750	24,900
OHIO		
Wapakoneta ...	$186,000	1,500
Columbus	1,125,200	10,000
Sandusky	1,515,000	6,000
PENNSYLVANIA		
Myerstown	$152,700	600
SOUTH CAROLINA		
Greenwood Co..	$2,852,000	15,000
Santee-Cooper..	37,500,000	15,000
SOUTH DAKOTA		
Flandreau	$168,770	648
TEXAS		
Lower Colo. R.A.	$20,000,000	67,500
Liberty	95,200	300
Leonard	72,727	150
Electra	221,818	600
VIRGINIA		
South Norfolk..	$331,000	1,500
TENNESSEE		
Knoxville	$2,600,000	.....
Lewisburg	100,000	.....
Columbia	204,000	.....
Chattanooga ...	4,330,000	.....
Memphis	6,872,000	.....
Newbern	59,000	.....
Paris	300,000	.....
Lenoir City.....	52,727	.....
Jackson	663,500	.....
Fayetteville ...	149,000	.....
Clarksville	250,000	.....

Diesels Prominent at Motor Boat Show

Many refinements of design rather than sweeping changes marked the numerous diesel engines displayed at the 33rd Annual National Motor Boat Show, held in New York, N. Y., January 7-15.

The National Supply Company's exhibit featured a 5½x7-in., 6-cyl engine developing 170 hp at 1500 rpm. Dual combustion is employed to secure complete burning and low peak pressures. All auxiliaries, including suction oil filter, are on the outside of the engine for convenience in servicing. A new bypass oil filter with replaceable cartridge lengthens oil life, and a water jacket on the filter serves as a temperature regulator.

Four engines of different types were shown by Fairbanks-Morse, including a 6-cyl, 720-rpm unit rated at 210 hp and equipped with reverse and reduction gears. Also displayed was a 20-kw, diesel-powered generator set, driven by a direct-connected, 40-hp, 1200-rpm engine.

Improvement in mechanical details represented the only change in the 2-stroke cycle, crankless engine exhibited by Sterling. This engine, of opposed piston design, is rated 150 hp at 1200 rpm.

Several high-speed engines attracted attention at the Cummins booth. One, a 4x5-in. 4-cyl engine, develops 35-56 hp at from 1200 to 2200 rpm, the highest diesel-engine speed at the Show. A similar engine, but with 6 cyl, has a rated hp of 46-85 over the same speed range.

Atlas-Imperial showed a heavy-duty direct-reversing engine of 6 cyl. At 325 rpm, this 9x12-in. engine develops 160 hp. At the other extreme of the speed range, Atlas featured a fuel-oil engine, with electrically-operated spray valves and spark ignition, which was rated at 65-90 hp at 2200-2800 rpm.

Largest diesel at the Show was Cooper-Bessemer's 8x10½-in. engine, capable of turning out 400 hp at 900 rpm. Five engines with Lanova head, ranging in size from 34 to 152 hp, were displayed by Buda. Other Diesel engine exhibitors included Hall-Scott, with a 5x6-in., 120-hp, 1800-rpm unit, and Waukesha with several Comet diesels and Red Wing-Waukesha-Hesselman fuel-oil engines.

MEETINGS

American Institute of Mining & Metallurgical Engineers—*Annual Meeting, Feb 14–17, Engineering Societies Bldg, New York, N. Y.*

Machine & Tool Progress Show—*Convention Hall, Detroit, Mich. Begins March 9. A F Denham, American Society of Tool Engineers, 5928 Second Blvd, Detroit.*

National Electrical Manufacturers Association — *Midwinter meeting, Waldorf-Astoria Hotel, New York, N. Y., February 7–12, W J Donald, managing director, 155 E 44th Street, New York, N. Y.*

Technical Assn of the Pulp & Paper Industry—*Annual Meeting, Feb 21–24, Waldorf-Astoria Hotel, New York, N. Y. R G Macdonald, secretary, 122 E 42nd St, New York, N. Y.*

Western Metal Exposition and Congress—*Pan-Pacific Auditorium, Los Angeles, Calif., March 21–25. W H Eisenman, secretary, American Society for Metals, 7016 Euclid Ave, Cleveland, Ohio.*

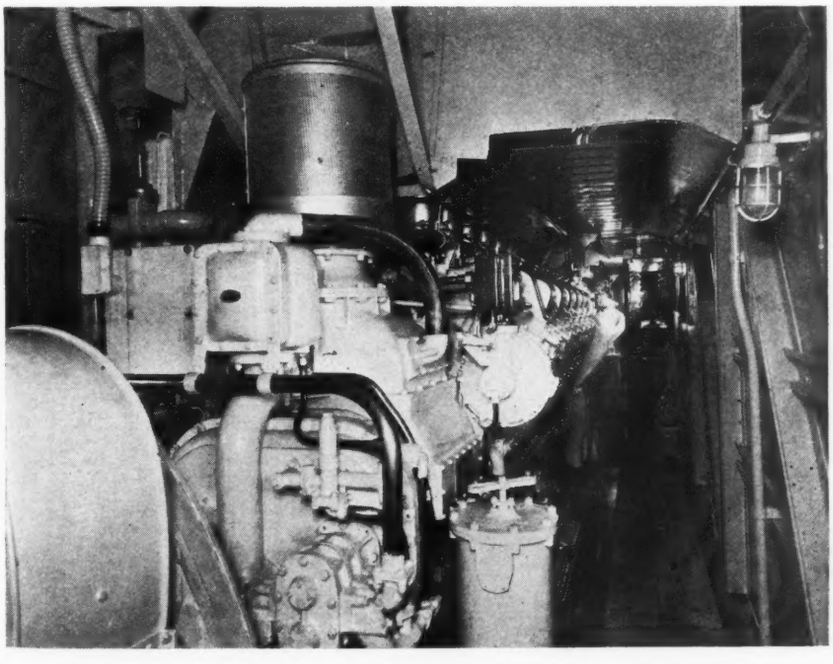
Mining Engineers Meet

The American Institute of Mining & Metallurgical Engineers will hold its annual meeting at the Engineering Societies Bldg, New York, N. Y., February 14-17. Among the technical papers to be presented are four on air-conditioning and ventilation of mines, and several papers on burning and washing of coal.

Reversible Diesel for Locomotive

The first locomotive in the world fitted with a reversible diesel has been constructed in England for hauling large steel ingots. Of the 4-wheeled type "0-4-0", it had to be restricted to a height of 7 ft, 3 in., so that it can haul heavy ingot bogies through low tunnels. It has only two speeds, 3 and 6 mph.

The locomotive is driven by a Crossley 4-cyl, scavenge-pump, 2-stroke reversible



RAILROAD DIESELS

One of six 900-hp, 12-cyl, V-type, General Motors diesels which power the new streamliner "City of Los Angeles" of the Union Pacific and Chicago & Northwestern railroads.

oil engine, with air starting. It has a 2-speed epicyclic gear box, and compressed air is for operating the clutch, changing gears and the brakes. Controls are duplicated at either side.

Oil from Coal in Australia

Production of oil from coal in Australia was thoroughly investigated during the latter part of 1936 by Sir David Rivitt, whose report has just become available, according to *Engineering*. The extremely rapid technical progress being made in the development of processes for making oil from low-grade coals is demonstrated by the fact that the delay of approximately a year in publishing this report was sufficient to affect some of the cost comparisons given.

The investigation was conducted with considerable care, however, and many of its conclusions still stand. It points out that several millions of pounds of capital have been lost in Australia on attempts at low-temperature carbonisation that have failed, and that this method depends on sale of semi-coke for success. It was shown that the hydrogenation process, or synthesis from gas by the Fischer-Tropsch process is best suited to the Australian problem. A complete economic analysis is given in the report, based on figures from German and English practice, showing that by hydrogenation, the cost would be about 13.8 d if made from bituminous coal, and 14.4 d if made from brown coal. By the Fischer-Tropsch process, the total cost would be about 13 d. Both figures may be considered high because of technical progress made recently, the figure for the Fischer-Tropsch process probably being the most out of line.

Since imported gasoline, at the time of this report, cost about 5 d. with a 7.5 d tax, it is obvious that it is impossible to recommend on economic reasons alone, the manufacture of oil from coal in Australia. However, the report does recommend action based on the fact that such a development would mean work for a skilled body of chemists and engineers and for some 3,000-4,000 men, and on the importance of having a home supply of airplane fuel and lubricating oil (only if the Fischer-Tropsch process were used would lubricating oil be available).

Finally, the report expresses grave doubts as to the future of petroleum supplies in many countries, even within so short a time as 12-25 years. An Empire conference is suggested to consider the matter, since any restriction of petroleum supplies would increase the value of these now economically undesirable processes.

Refrigeration Engineers Meet in New York

A well-rounded program of technical papers on current refrigeration and air-conditioning problems has attracted a large advance registration for the 33rd annual meeting of The American Society of Refrigerating Enginners, which opened January 25th at the Hotel Roosevelt in New York, N. Y.

Refrigeration men in attendance at the 3-day meeting will also take in a joint session with the ASHVE and the International Heating and Ventilating Show at Grand Central Palace, New York.

The complete program for the technical sessions follows:

Tuesday, Jan. 25

"Refrigeration in Modern Breweries," George B Bright, consulting engineer, Detroit, Mich.

"The Field of the Food Technologist," Professor B E Proctor, MIT, Cambridge, Mass.

"How Cities Are Fed," informal talk by Walter P Hedden, Chief, Bureau of Commerce, Port of New York Authority.

"Flow of Refrigerant Fluids," A B Stickney, Chicago, Ill.

"Viscosity of Oils Diluted with Refrigerants," O C Rutledge, General Electric Co, Schenectady, N. Y.

"Industrial Relations," informal talk by L A Ruthenberg, President, Servel, Inc, New York, N. Y.

Wednesday, Jan. 26

"Heat Transfer in Ammonia-Cooled Shell-and-Tube Brine Coolers as Affected by Operating Conditions," J C Consley, York Ice Machinery Corp, York, Pa.

"New Insulation Studies," F G Hechler and E R Queer, State College, Pa.

"Economic Aspects of Refrigeration," David L Fiske, Secretary ASRE.

"The Thermodynamics of the Absorption Refrigerating Machine," B H Jennings, Professor of M E Lehigh University, Bethlehem Pa., and F P Shannon, Philadelphia and Reading Coal & Iron Co, Philadelphia, Pa.

"Controls for Air Conditioning in Large, Medium and Small Buildings," W E Zieber and S F Nicoll, York Ice Machinery Corp, York, Pa.

"Fire-Proof Air Ducts," R H Heilman, Mellon Institute, Pittsburgh, Pa.

"Physiological Reactions and Sensations of Comfort under Various Atmospheric Conditions," C E A Winslow, L P Herrington and A P Gagge, John B Pierce Laboratory, Yale University.

Thursday, Jan. 27

"Refrigeration Storage Applied to Air Conditioning," W F Friend, Ebasco Services, Inc, New York, N. Y.

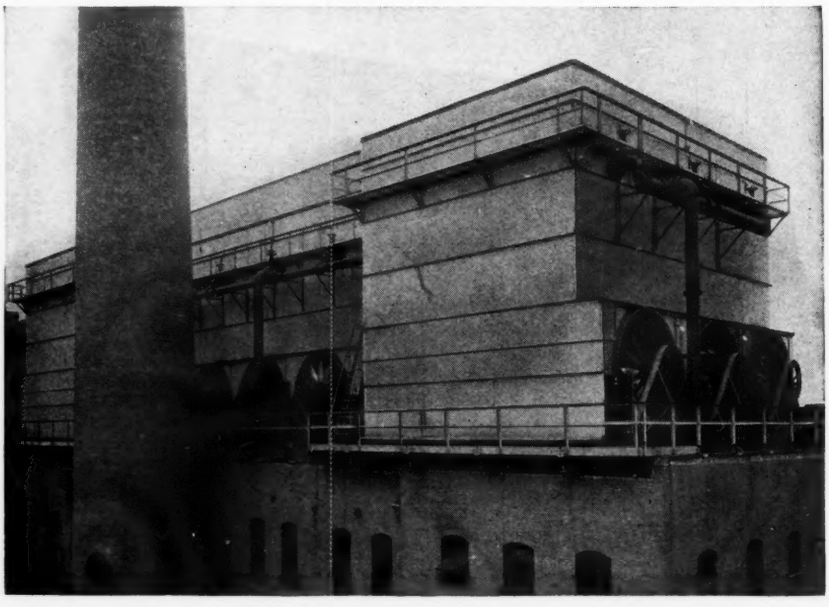
"Effect of Superheat on Condensing Unit Efficiency," L W Child, Evans Products Co, Detroit, Mich.

"Extended Surface Cooling Units—Design Calculations," by R H Swart, General Refrigeration Sales Corp, Beloit, Wis.

"Trade Schools in Refrigeration," informal talk by Dr. J S Noffsinger, National Home Study Council, Washington, D. C.

Survey Made on Power Supply in Floods

Power supply in floods and other emergencies along the Ohio River will be protected and its continuity assured by improvements and interconnections made and projected as a result of the surveys conducted and measures adopted since last year's disastrous flood, the Federal Power Commission and the Public Service Commission of Kentucy conclude in their joint report, made public Jan. 17 on "Protection of Electric Power Supply in Kentucy During Ohio River Floods." The engineering report covers in detail the principal flood areas



13,000-GPM COOLING TOWER

This cooling tower, one of the largest forced-draft installations ever made for a brewery, has just been completed for the Jacob Ruppert Brewery by the Cooling Tower Co, New York, N. Y. The tower cools 13,000 gpm of water for condensing steam and for cooling ammonia-condensing water for refrigeration

in Kentucky, Ohio, Indiana, Illinois, and West Virginia, from Huntington, West Virginia, to Cairo, Illinois.

The following general conclusions may be drawn from the experiences of the electric utility companies along the Ohio River during the 1937 flood, the Engineering report states:

(1) Well designed and constructed and properly located or protected transmission lines and transmission structures are practically immune to flood damage.

(2) Outdoor switchracks and substations resist flood damage almost as effectively as transmission lines.

(3) Interconnections were of vital importance during the 1937 flood emergency and would prove equally useful in any other unpredictable disaster that might incapacitate important generating station or substation equipment.

(4) Steam-electric generating stations can be designed or remodeled to operate under practically any flood condition.

(5) Large steam-electric generating stations to be constructed in future in this area should be so protected by dikes, flood walls, building reinforcement or other design features as to make station operation secure under extreme flood conditions.

(6) Flooding and prolonged immersion of large generating, transforming and switching equipment do not necessarily result in serious permanent damage (except to very old equipment) provided sufficient time and pains may be taken in drying out and reassembling.

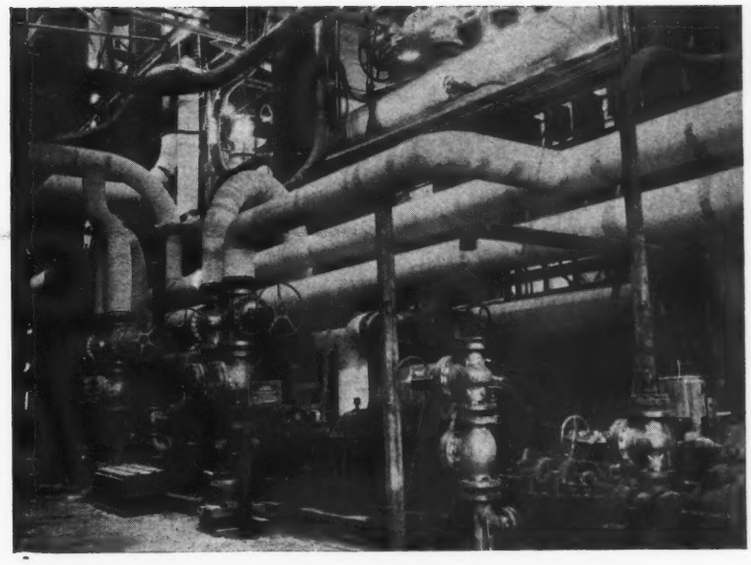
(7) More pains should be taken in the construction of cable potheads and in their location, so far as possible, above flood levels.

(8) When a power shortage occurs, the most serious of the evil effects may be mitigated and largely avoided by rationing of the power supply.

(9) The effectiveness with which the flood emergency was handled in different communities was fixed largely by two factors: (a) The extent to which the transmission and distribution systems were constructed to form networks rather than radial lines. (b) The extent to which the management anticipated emergency conditions before they actually arose, and mobilized men and material, equipped with well thought out plans, to take the necessary remedial measures.

"Both items, and also the effectiveness of emergency rationing of the power supply," the report states, "are largely a matter of planning by capable engineers. This type of protection against floods and other emergencies is probably the most important and least expensive of all the protective measures that can be taken."

Power Piping at Carnegie-Illinois Plant



This unusual view of modern power piping (above) as made at the Carnegie-Illinois Steel Co's. new No. 5 Power Station, located at the South Works, Chicago. Expected to be in preliminary operation by this time, the new plant has a capacity of 25,000 kw with provision for future expansion in the form of a single 50,000 kw unit. To take advantage of byproduct fuel and at the same time to burn the cheapest auxiliary fuel available, the three 300,000-lb-per-hr. four-drum, bent-tube boilers are equipped with blast-furnace-gas burners, to fire that portion of the blast gas available over the demands of gas engines and metallurgical furnaces, and with both natural-gas and oil burners. In addition, space for coal handling equipment and pulverizers is provided so that should future conditions warrant, a change could be made to this fuel.

General Motors Enters Industrial Diesel Field

On January 19, General Motors Corp launched a program for manufacturing a complete line of lightweight, 2-cycle diesels for industrial, marine and railroad applications. The engines will be built in one existing factory and two new plants, of which The Detroit Diesel Engine Div is in operation, and the other, the new engine factory of Electro-Motive Corp's diesel locomotive plant at LaGrange, Ill., will be in operation within a few months. The existing factory is the Cleveland Diesel Engine Div (formerly Winton Engine Mfg Corp) at Cleveland, Ohio.

Three series of models will be manufactured, based on three different cylinder sizes. Model 71 series will include 1-, 3-, 4- and 6-cyl engines rated from 22 to 160 hp maximum at 1800 rpm. Model 223 series will include 4-, 6- and 8-cyl engines rated for industrial and marine uses at from 200 to 400 hp. The larger series is the present line of engines now in railroad, marine and stationary-power service, including 8-, 12- and 16-cyl engines ranging from 600 to 1200 hp.

General Motors intends to sell complete "power packages" for industrial and agricultural applications. For example, in the case of a stationary electric plant, the package will include engine, generator, fuel-supply equipment, switch board, radiator or heat exchanger, base and other necessary equipment.

J. W. Rickey Retires

James W Rickey, chief hydraulic engineer of the Aluminum Co of America, who has had charge of construction of all the hydroelectric plants of the company built since 1907, retired from his position at the first of the year. All of the company's dams and power plants, with the exception of the relatively small Niagara Falls and Massena, N. Y., plants, were built during Mr. Rickey's term of service. Mr. Rickey is succeeded by James P Growdon, who has been his principal assistant since 1925. Mr. Rickey has agreed to continue as consulting engineer for the hydraulic department.

Mr. Rickey, who was born in 1871, graduated from Rennselaer Polytechnic Institute in 1894 and went to work for the Northern Pacific RR, Minnesota division. Two years later he left that position, and, after a year's service as first assistant engineer for the Lake Superior Power Co, he joined the St. Anthony Falls Water Power Co.

OBITUARIES

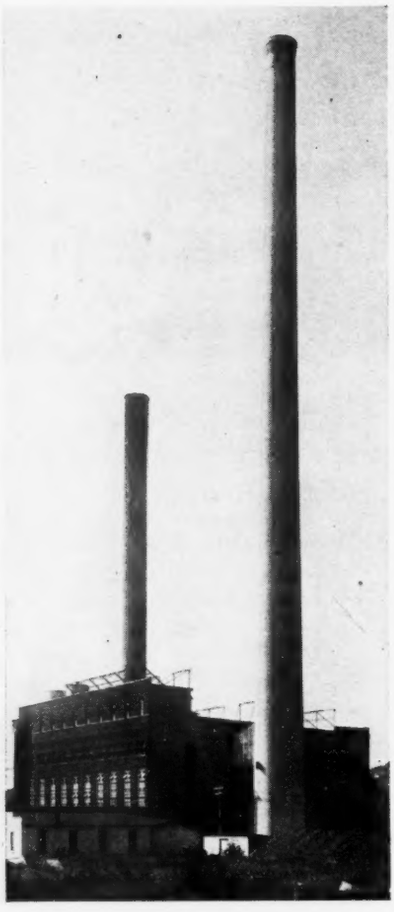
JUST before going to press, we learned that E R Shaw, 67, publisher of *Power Plant Engineering* and long-time treasurer of the Audit Bureau of Circulation, died January 12 in Tucson, Ariz., where he went six weeks ago. Death was due to thrombosis, following a long illness of arthritis. A complete obituary will be published in March.

PAUL B HUYETTE, 66, president of the Paul B Huyette Co., Inc, for the past 43 years, and well known in the power engineering field for many years, died January 13 at his home in Philadelphia, Pa., after an illness of two weeks.

JOSEPH S HAMMERSLOUGH, vice-president of Springfield Boiler Co, Springfield, Ill, died Dec 11.

SAMUEL MOORE, 72, for many years general superintendent of the Service and Erecting Div, Allis-Chalmers Mfg Co, died suddenly in Milwaukee on Dec 14.

(*Continued on page* 126(124b))



TALL CHIMNEY

This power-plant chimney, 409½ ft high, believed to be the highest in eastern U.S., was recently completed for Marion Reserve Power Co, at its Scioto station near Marion, Ohio. The chimney has an inside top diameter of 14 ft, comparing with an inside top diameter of 25 ft and a height of 600 ft for one of the world's tallest chimneys, built for Nippon Mining Co at Chinnampu, Korea, last year

STRAWS

Pointing the way business winds blow

ALABAMA —— Montgomery Oak Flooring Co, Montgomery, plans boiler house in connection with rebuilding of woodworking mill recently destroyed by fire. Loss about $100,000, with equipment.

CALIFORNIA —— State Dept of Public Buildings, Sacramento, contracted Campbell Const Co, Sacramento, at $29,615, for water-treatment plant at Sonoma State Home, Eldridge.

Board of Kern County Supervisors, Bakersfield, plans central-heating plant in 4-story hospital at East Bakersfield, for which bids will be asked soon on general contract. Cost about $250,000. C H Biggers, Haberfelde Bldg, Bakersfield, architect.

Surprise Valley Elec Corp, Alturas, will soon award contracts for steam-electric generating station near Alturas. Cost over $100,000. T Ruegg, 251 Kearney St, San Francisco, architect.

San Mateo Junior College and High School District, San Mateo, plans central-heating plant in new multi-unit junior college at Peninsula Ave and North Delaware St. Cost over $300,000. H A Thomsen, 315 Montgomery St, San Francisco, architect.

CONNECTICUT —— Boards of Education of Canaan, North Canaan, Cornwall, Salisbury, Kent and Sharon plan central-heating plant in new joint regional high school at Lyme Rock, for which bids are scheduled to be

(*Continued on page* 116 (122))

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Los Angeles — Southern California Edison Co., Edison Bldg., plans following construction work during 1938, incl. completion of Boulder transmission line to Chino sub-station, $600,000; extensions at Chino substation, $1,130,000; miscellaneous transmission lines, $1,000,000; substation at Santa Monica, $103,000; substation at Huntington Park, $185,000; substation additions in Santa Barbara and Pasadena, $325,000. Total $3,343,000.

Calif., Santa Monica — Southern California Edison Co., Edison Bldg., Los Angeles, plans completed constructing rein.-con. substation building (power substation), $103,000. Owner's Engineering and Architectural Dpt., Los Angeles, engrs. and archts.

Colo., Pueblo—Denver & Rio Grande Western R. R., A. O. Ridgway, ch. engr., Equitable Bldg., Denver, plans steam power plant additions, $40,000.

Fla., Miami—Florida National Building Corp., 2nd Ave. and East Flagler St., plans diesel power plant for bank and office building. $250,000.

Ia., Clinton—City Council plans constructing municipal electric light and power plant. Interstate Power Co. lost election over proposed 25 year franchise. The company's present franchise ends in March.

Ky., Beattyville — City plans municipal power plant. $90,000 bond issue approved.

Ky., Vanceburg—City plans municipal electric light and power plant. $148,000 bond issue approved.

La., Plaquemine—City retained L. J. Voorhies, engr., Baton Rouge, to make survey of existing electric light and power system.

La., Shreveport—Southwestern Gas & Electric Co. plans plant improvements, incl. addition to Arsenal Hill power plant. $3,250,000. **Maturity 1938.**

Me., Solon—Central Maine Power Co., Solon, plans hydro-electric power plant at Caratunk Falls, near here. To exceed $40,000.

Mich., Paw Paw—Municipality plans hydro-electric power plant. $100,000.

Mich., Wahjamega—State, State Administrative Bd., Lansing, plans by E. R. Little & Co., engrs. and archts., 1801 Ford Bldg., Detroit, 2 story, basement, brick, steel, rein.-con. steel power plant plain found. $265,000.

Minn., Anoka—Municipality bids in March, constructing hydro-electric power plant. To exceed $40,000. G. M. Orr Co., 542 Baker Arcade, Minneapolis, engrs.

Miss., Itta Bena—Bids Feb. 1, by City, c/o Clerk, new generating equipment, changes in distribution system to convert from DC to AC new water pump, meters and service connections, etc. $50,000. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., engrs.

Neb., Elgin—Interstate Power Co., Elgin, plans auxiliary power plant. Est. about $40,000.

N. Y., Murray—Niagara, Lockport & Ontario Power Corp., Lockport, plans electric plant. Authority has been received from Pub. Serv. Comn., Albany, to proceed with project.

N. Y., Port Byron—New York State Electric & Gas Corp., Elmira, plans electric plant for transmission purposes. **Maturity soon.** Public Service Comn., Albany, granted authority to construct.

O., Cleveland—City, F. D. Wallene, dir. P. Utilities, plans constructing and installing 25,000 k.w. turbo-generator units, $2,131,000; replacing boilers 10 to 14, $325,000; and installing 12,500 k.w. generator, $2,727,000, for municipal light plant, East 53rd St. and Lake Erie. Total $5,183,000. L. O. Quayle, 105 City Hall, ch. engr.

O., Dayton—Cimatool Co., 1517 East Third St., plans construction steam power plant. $150,000.

O., Nelsonville—City, approved $90,000 bond issue for constructing municipal light and power plant. G. M. Coakley, 180 North Washington St., engr. R. G. Ingelson, 299 South Front St., Columbus, consult. engr.

O., Xenia—Wilberforce University, Xenia, plans power plant improvements. To exceed $40,000.

Okla., Vinita—Grand River Dam Authority, Vinita, filed with Federal Power Commission its declaration of intention to construct dam about 147 ft. high above rock bed and will create 2,000,000 acre ft. capacity reservoir in Grand River and hydro-electric plant, incl. 80,000 hp. generating plant, in Mayes, Delaware, and Ottawa Counties for flood control, irrigation, and power development. Federal government has made grant of $8,437,000 to authority and agreed to loan $11,563,000 through purchase of its revenue bonds. Total $20,000,000. W. R. Holway, Tulsa, consult. engr.

Ore., Eugene—City plans new unit for steam standby plant for Public Utilities capable generating 6,000 kwh. to provide city with adequate reserve power to take care of peak loads. $489,700

Pa., Butler—General State Authority, A. S. Janeway, executive secy., 600 North 2nd St., Harrisburg, sketches by E. B. Lee, Chamber of Commerce Bldg., Pittsburgh, and takes bids in March, for group of buildings at Western State Tuberculosis Sanitarium on 130 acre Robinson Farm, 2 mi. southwest of here, opposite Butler County airport, including power plant, with two 600 hp. high pressure boilers with automatic stokers, 165 ft. radial brick stack, 500 ft. tunnel, 5x7 ft., underground, to connect power plant with all buildings in group and to carry service lines, water supply system, incl. 100,000 gal. water tower and basin, reservoir, service and fire lines, sewage disposal plant, incl. septic tanks, 10,000 lin. ft. sewer lines. Total cost $2,108,643.

Pa., Edinboro — Commonwealth of Pennsylvania, A. S. Janeway, executive dir., 600 North 2nd St., plans by R. Irvin, Starr Bldg., Pittsburgh, 1 story power plant, incl. water and steam lines, sewers and emergency lighting system, at State Teachers College. $160,000.

Pa., New Castle—Commonwealth & Southern Co., 20 Pine St., New York, constructing steam power plant, separate contracts; furnishing 1,500 tons structural steel for same, to Ingalls Iron Wks., 720-4th Ave. S., Birmingham, Ala. Total est. $2,800,000.

Pa., Perkasie—Borough Council of Perkasie, P. Bader, secy., 7th and Arch Sts., takes bids before Mar. 1, 60 ft. addition to present municipal electric plant, relocation of equipment, installing new boiler, coal pulverizer, water sifter, larger coal conveyor, $120,000. Gurenwald & Niemitz, 316-17 Bulletin Bldg., Phila., engrs.

Pa., Titusville — J. Fay, city engr., making survey to determine cost repairs, alterations and improvements to municipal light and power plant, for City.

Pa., West Pittston—Scranton Electric Co., Scranton Electric Bldg., Scranton, plans constructing transformer sub-station, Elm St. $138,000. Maturity as soon as project is approved by the Public Utility Comn. Owner's own engineering staff, engrs.

Tenn., Chattanooga — Chattanooga Electric Power Board, City Hall, soon takes bids transformers for three sub-stations $105,000; 14 oil circuit breakers $100,000. S. R. G. Finley, City Hall, engr. Plans and specifications to be presented to K. Markwell, P.W.A. ch. project engr., Volunteer Bldg., for approval.

Tex., Brenham—City, c/o R. B. Lockett, mayor, soon takes bids constructing electric generating plant and distribution system. P.W.A. project. Garrett Eng., Co., Box 1726, Houston, engrs.

Tex., Electra — City, c/o A. B. Corder, mayor, soon takes bids light and power plant, electric generating plant and distribution system. $221,000. J. E. Ward, Harvey Snider Bldg., Wichita Falls, engr.

Tex., Jacksonville—Soil Conservation Committee, c/o C. K. DeBusk, managing dir., Jacksonville, surveys started by U. S. Engineers, constructing dam and reservoir, etc., reservoir will cover 80,000 acres land and have 2,000,000 acre ft. of water. It is estimated to produce over 20,000 kv. of electric energy, in addition to providing flood control and water, location in McGee Bend on Angelina River, west of Jasper, and above confluence of Neches and Angelina River. Meeting in January on further development. Myers, Noyes & Forest, c/o Conservation Committee, Jacksonville, and Tower Petroleum Bldg., Dallas, engrs.

Tex., Leonard—City, c/o R. D. Wing, mayor, Leonard, soon takes bids constructing electric generating plant and distribution system, $75,000. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, engr.

Tex., Liberty—City, c/o T. Calhoun, mayor, soon takes bids constructing light and power plant, street light system, etc. $95,000. P.W.A. project. Garrett Eng. Co., Box 1726, Houston, engrs.

Wis., Clayton—Stella Cheese Co., c/o A Castigliano, 208 Metropolitan Bank Bldg., St. Paul, Minn., plans nearing completion constructing power house, two 150 hp. boilers, heater, etc. R. W. Richardson, 202 Oppenheim Bldg., St. Paul, Minn., engr.

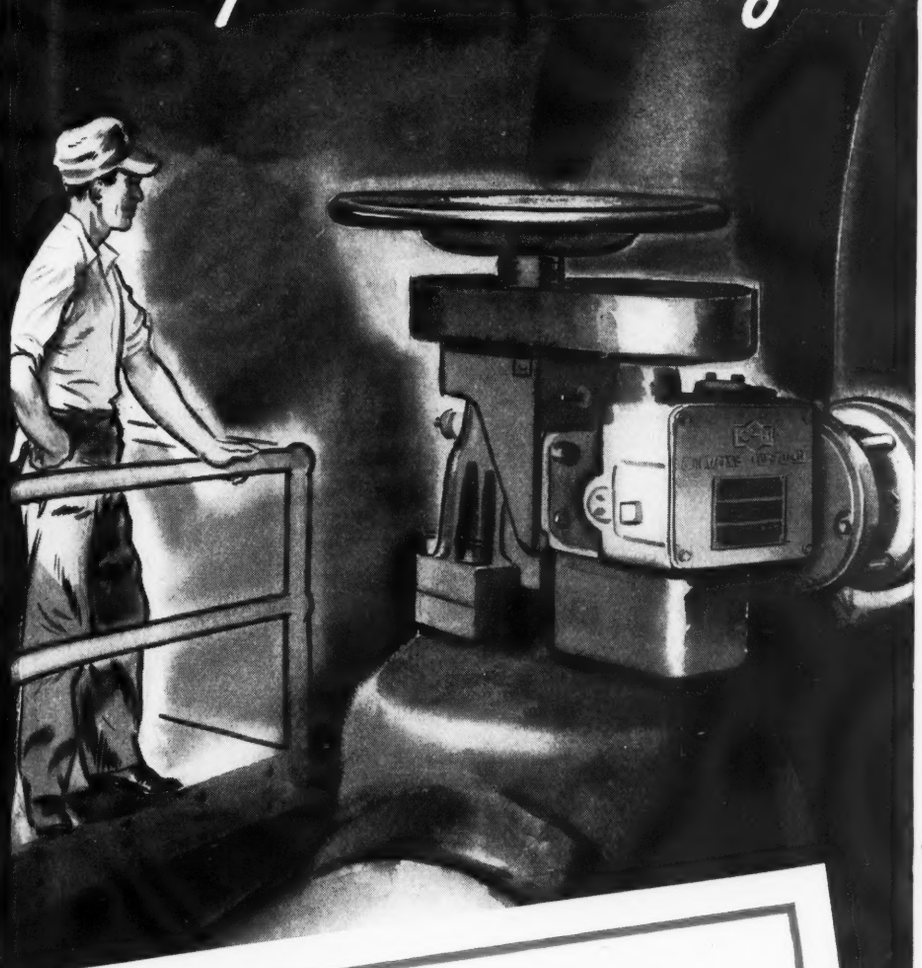
N. S., New Glasgow—Picton County Power Bd. making plans constructing complete steam generating plant. $250,000. D. Dunbar, New Glasgow, engr.

Ont., Toronto — Ontario Hydro-Electric Power Comn., 14 Carlton St., plans high tension power transmission lines from Beauharnois on St. Lawrence River to Leaside; constructing high tension line from Leaside to Commission's Strachon Ave. plant in Toronto; installing additional transformers. B. O. Salter, Toronto, purch. agt.

Australia — Government of State of Victoria, **Melbourne**, voted $43,750,000 to State Electricity Commission for extensions, increasing generating capacity by 200,000 kw. Plans for 50,000 kw. increase at Yallorne and 30,000 kw. at Newport, will be called early in 1938, and for constructing 2 circuit 165,000 volt transmission line on steel towers from headwaters of River Kiewa to Melbourne 160 mi., also for 66,000 volt line to Wangaratta will be called in spring.

Africa, Nigeria—Nigerian Electricity Supply Corp., Kurra, preparing plans hydro-electric power development at Jekko Falls and will be in market for much machinery.

The Most Complete... The Most Thoroughly Engineered Line of Valve Control



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LARGE For steam line temperatures so hot the valve glows . . . on pressures up to 3,000 lbs. . . . . on liquid and gas valves . . . Cutler-Hammer B5 brings nearby or remote control at the touch of a button; sure starting, sure travel, sure seating; speed . . . and safety.

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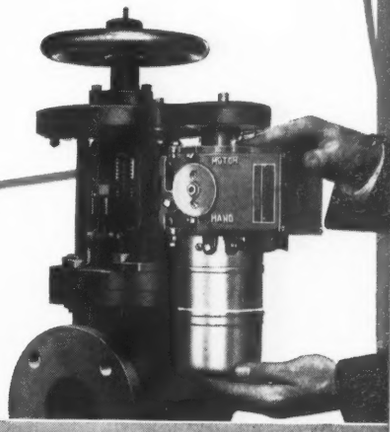

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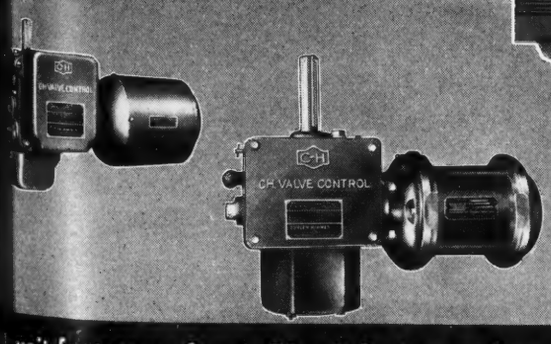

unit for torques from 30 to 125 lbs. ft.

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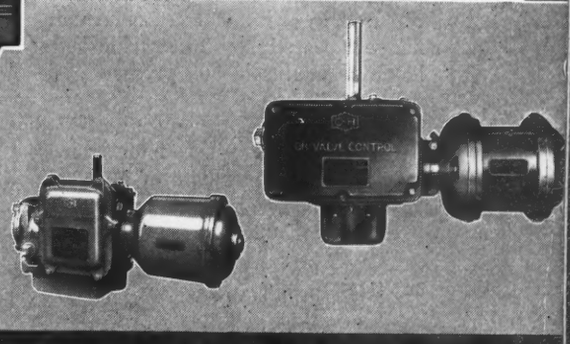

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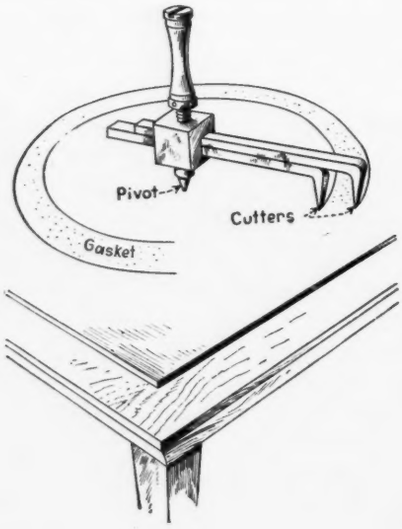


Adjustable Cutter for Ring Gaskets

A SIMPLE and efficient tool for cutting ring gaskets from sheet packing is illustrated. The body or block that serves as pivot holder, lockhandle and cutter-bar cross head is made of machine steel and the cutter bars of carbon steel. The lockhandle is capstan drilled on the lower collar to permit using a pin to tighten or loosen its threaded tip that locks the bars.

In use, the two bars are adjusted to the required diameters and locked. Then, the pivot point is pressed down by hand on the packing. By gripping the outer bar at its tip, the operator swings it as a compass and bears down into the sheet to cut out a ring gasket.

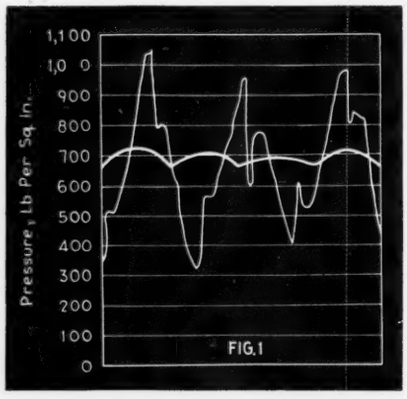
Penacook, N. H. C H WILEY

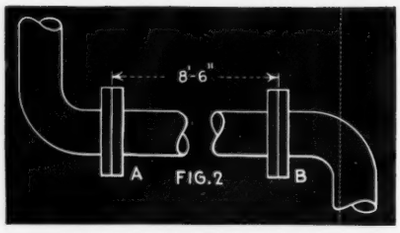
Reducing Leaks in Pipeline Flanges

ALMOST from the day pumping started, flange joints on the discharge lines leading from four duplex double-acting pumps gave trouble. Flanges of the usual type were welded to the 6-in. line on each side, as were the only separable joints between pumps and the 8-in. main line. Each flange had eight 0.75-in. bolts, which were replaced by $\frac{7}{8}$-in. bolts after reaming flange holes slightly to provide better holding against the pressures developed.

Normal working pressure of 675 lb per sq in. produced a total endwise load on the flange bolts of 19,000 lb, based on nominal pipe diameter and pressure. That this pressure was greatly exceeded was demonstrated by setting an indicator with a 600-lb spring on one pump. Fig. 1 shows the pressure range on the discharge manifold of this pump from 1,030 lb maximum to 330 minimum. Consequently, flange joints were subjected to 29,121 lb at maximum load. A dial indicator was set up on the flange bolts and the elongation measured, averaging as high as 0.0007 in. per stroke for quite considerable periods, which overstressed the bolts.

Much more trouble was experienced keeping joint *A*, Fig. 2 tight than *B*, only 8.5 ft away. Repeated tightening of bolts kept down leakage, but





it was not until the line was opened that the trouble was cleared up. Joint *A* had a lead gasket, that at *B* was of a plastic material. Since the lead gasket is practically non-elastic, it hammers thinner under the repeated impacts of the flange faces, requiring frequent tightening to maintain line seal, while the plastic material expands and follows the flange faces through the pressure cycle.

As a result of the investigation, metallic gaskets and joint rings were removed from all check covers, gates and other points subjected to a pulsating pressure, and replaced with plastic materials. A further improvement was made by cutting the inside diameter of gasket material from $\frac{1}{8}$ to $\frac{1}{4}$-in. smaller than the inside diameter of the flanges. This slight shoulder of material protruding within the line affords a seal against the beginning of gasket attrition, sometimes noted when fluid under-pressure tends to scour out the gaskets between flanges.

Since gasket material was changed and larger bolts were used in the flanges, there has been no further recurrence of leakage. Additional protection was gained by installing adequate air chambers on the discharge lines.

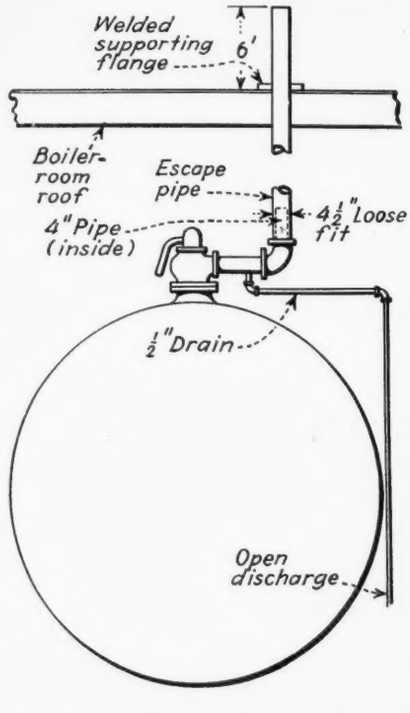
Longview, Texas M T PATE

Escape Pipes for Safety Valves

A PROPER escape pipe is as essential to the safety of plant personnel as the safety valve is to the boiler. Too often a man has been opening a stop valve when a safety valve, having no escape pipe, and pointing directly at him, pops. To be standing in the path of a high-pressure, 3- or 4-in. jet of steam is usually fatal.

Every safety valve should have an escape pipe at least 6 ft high. If head room makes it impossible to terminate this pipe within a reasonable distance from the ceiling, it should extend out through the roof. If it is a flat roof where workmen may be, the escape pipe should extend at least 6 ft above the roof. If a horizontal escape pipe is more practical, it should discharge away from where workmen might be.

It is essential that the escape pipe



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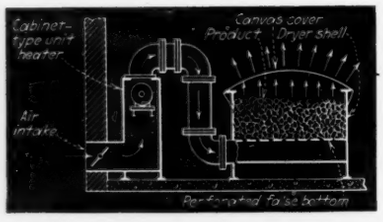
be at least equal to the size of the safety valve. If a length of over 12 ft is necessary, it is better to use 0.5 in. larger diameter for each 12 ft in length. A long line with no increase in diameter will cause a back pressure because of flow friction, and it may cause serious chattering of the safety valve. One 90-deg. turn is usually necessary next to the safety valve. Avoid other 90-deg. bends if possible.

Support an escape pipe independently of the safety valve. Serious stresses may be set up in the safety-valve body, connection, or boiler nozzle by the weight of a heavy unsupported escape pipe.

After a safety valve has blown many times, it is not uncommon for slight leakage to develop. Condensation of this leakage may gradually fill an undrained escape pipe with water. This condition alone prevents the safety valve from blowing at its set pressure. The popping point will be increased one pound for every 2.3-ft elevation of water in the escape pipe. Also, in an outdoor escape pipe exposed to severe winters, ice may form and seriously interfere with proper safety-valve operation. Every escape pipe should have a $\frac{3}{8}$- or $\frac{1}{2}$-in. open drain at its lowest point. This drain should be conducted off of the boiler top in order to prevent external corrosion induced by dampness. The figure shows a properly installed safety valve.

Boston, Mass. C O DIBBLE



Unit Heaters Used As Process Dryers

UNIT heaters can often be used to supply warm air for drying and other process operations where the quantities of materials handled are small and operating conditions make the purchase of more efficient commercial equipment uneconomical. One application of a floor-type heating unit used to dry the product of a chemical plant is shown in the drawing.

The dryer consists of a circular sheet-metal vat having a perforated false bottom. Hot air from the heater circulates upward through the product piled on this bottom. A canvas cover over the dryer prevents any of this material from escaping into the room.

During the winter months this dryer, in addition to performing its normal function, acts as a humidifier for the air in the surrounding building space. In summer, an exhauster fan removes the hot humid air from above the dryer, preventing any undue temperature rise in the building.

Among other applications of unit heaters in industry are supplying warm air to laundry and cleaning plant dry rooms, operated as circulating fans during summer months with no steam on the heating coils. Where room heat release is high, their use as either heaters or exhausters depends upon the temperature requirements.

Richmond, Va. C R ANDERSON

Wiping-Cloth Cost Reduced by Washing

COST of wiping cloths is one of many items in total expense for supplies necessary to maintain a well kept plant. A number of nationally known manufacturing organizations have effected substantial savings by substituting high-grade cloth material for the ordinary mixed rags of varying quality sold commercially. These cloths are laundered when they become dirty and are reused many times before being discarded. Washing is done with equipment either provided especially for this purpose or having additional uses such as cleaning overalls, uniforms, linens and other materials.

While initial outlay for laundering equipment makes this procedure uneconomical in smaller plants, there is always the commercial laundry. It is often possible to have wiping cloths laundered in these establishments at a mutual profit to both parties concerned. A large chemical plant found it profitable to have an outside laundry experiment with the washing of filter-press cloths previously burned as unreclaimable. These experiments proved so successful that the total wiping-cloth requirements of the plant now come from this source.

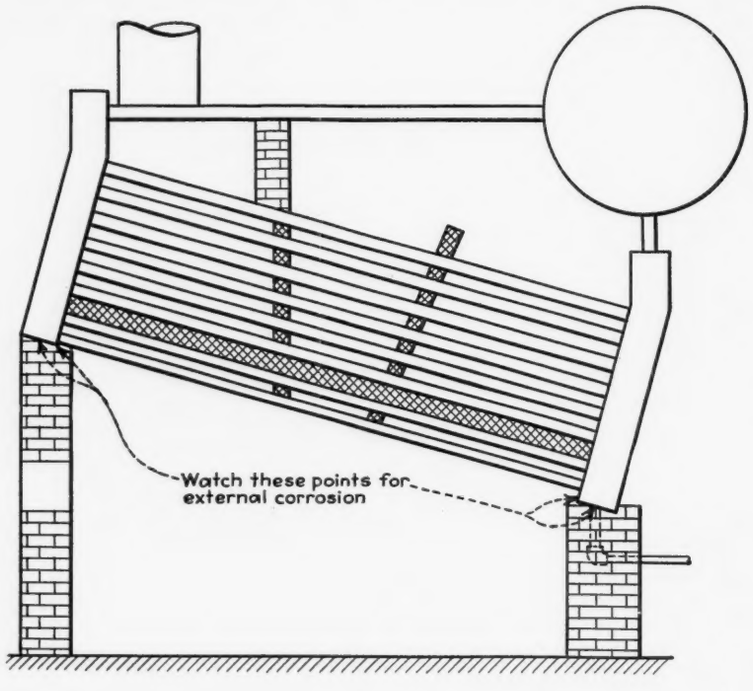
Roanoke, Va. S H COLEMAN

Check Bottom of Box Headers

THE HEADER BOTTOM in box-header-type boilers is not readily accessible and is often neglected. This part is generally known as the trough, and forms the bottom of the header. The header trough usually rests on a bearing plate set on brickwork, and to seal the combustion chamber and passes against air infiltration, the header bottom is sealed with some plastic preparation, or asbestos rope. This type of construction is satisfactory for the purpose intended, but it makes the header trough inaccessible for examination.

Soot usually finds its way into all cracks and voids under the trough. Every time a tube, tube cap, or gasket leaks, water will run down on to this soot. Sulphur in the soot reacts to form a sulphurous acid, causing corrosion, which may do serious damage in less than one year.

It is advisable to remove sufficient brickwork and insulation to observe the condition of this trough at least every 5 years. This should be done immediately if there is any indication



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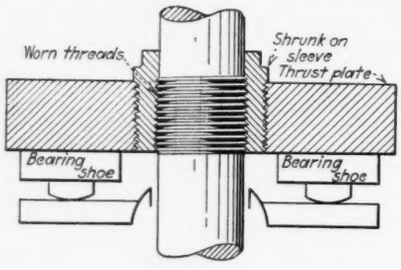
of leakage or other defects in a hidden section. This article is not intended to imply that the box-header type of boiler is undesirable, but to call attention to a section of the boiler that may be overlooked during inspections. Leaky gaskets, or continued dampness may cause serious damage in any type of boiler.

Chicago, Ill. R O BILLINGS

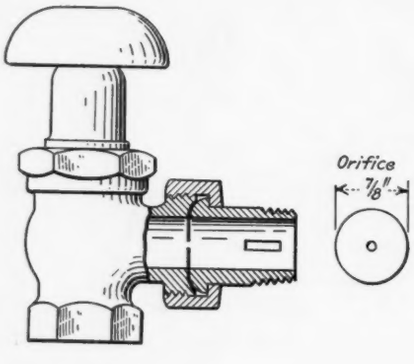


Repairs Made on Thrust Bearing

THRUST-COLLAR threads on an 1875-kva vertical waterwheel-generator shaft were so badly damaged by overheating from oil failure, that their ability to carry load was doubtful. As the machine would have to be dismantled and part of the building torn down to install a new shaft, the job was done as in the figure.

A sleeve, threaded on the inside to go on the shaft with a shrink fit, and threaded on the outside for the thrust plate, was installed on the shaft. After reboring and threading the thrust plate to fit the sleeve, it was installed. Since then, the machine has been in service for several years without giving any thrust-bearing trouble.

Kearney, Neb. ED SWAN



Radiator Orifices Reduce Heating Costs

WE operate a 48-story building, having 5,500,000 cu ft of space, and equipped with 1800 radiators totaling 67,000 sq ft of surface. Steam is purchased and the building is six years old. Before this year, we averaged 0.6 lb of steam per degree-day per 1000 cu ft of space, with manual control. Estimates of cost for orificing the radiators and controlling temperature were made, but the owners would not spend the money. Phil Swain, in "Speaking of Power," in the November *Power,* was right, ". . . work like hell and don't spend a damn cent."

Orifice Diameters and Radiator Sizes

Orifice Dia, In.	Radiator Area, Sq Ft	Orifice Dia, In.	Radiator Area, Sq Ft
3/32	18	3/16	61
7/64	24	13/64	70
1/8	30	7/32	80
9/64	37	15/64	91
5/32	44	1/4	102
11/64	52		

This year we made and installed orifices as in the figure. We had copper disks $\frac{7}{8}$ in. in diameter cut at a cost of $9 per 1000, to put into the unions of the radiator supply valves. The elevator mechanic rigged up a drill chuck on the spindle of an emery wheel and easily bored the holes, as indicated in the table, by gripping six disks between two pairs of pliers and holding them against the drill.

The size of the holes in the disk are for a full radiator at atmospheric pressure and are varied to suit radiators nearest the supply as well as the distant ones, to take care of slight differences in steam pressure. One man installed the orifices in nine days.

So far this year, heating has been satisfactory throughout the building and has been done with about 20% less steam per degree-day than before the orifices were installed. Previously, the building was difficult to heat from the tenth floor down; now this section tends to be a little warmer than the upper sections.

New York, N. Y. THOMAS SHEEHAN

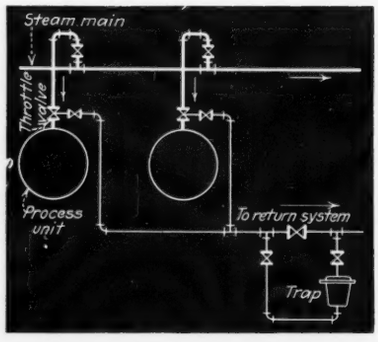
Fan Rotation Corrects Bearing Trouble

IF YOU have rol'er-bearing installations and are experiencing excessive maintenance costs, perhaps the answer we found will also guide you. We have a number of motor-driven fans which required annual renewal of the roller bearings. They operate on an average of 6 hr per day, about 2200 hr per year, being idle the remainder of the time.

Inspection of bearings showed evidence of pitting. The pedestals were checked, and on one side were found effectively insulated to prevent shaft currents. Inspection also showed no external pipes or conduits connected to the frames and acting as bridges across pedestal insulation. Chemical analysis was made of the lubricant, but nothing could be found that would account for the electrolytic action.

It was found, however, that the foundation beams, although strong enough to support the motor-fan assembly, had not been rigidly braced before the concrete mat had been poured. It was assumed that probably the beams transmitted building vibration to the fan bearing. Theoretically it seemed a little far-fetched, but no definite answer to the problem had as yet been found, so any reasonable possibility was considered. On the assumption that vibration was the cause of excessive bearing maintenance, we reasoned that this condition probably only existed when the fans were not in operation. Damper adjustments were then made so that fans rotated by back pressure during the periods of idleness at about 6 rpm. Since this scheme was put in operation over two years ago, no roller bearings have been renewed.

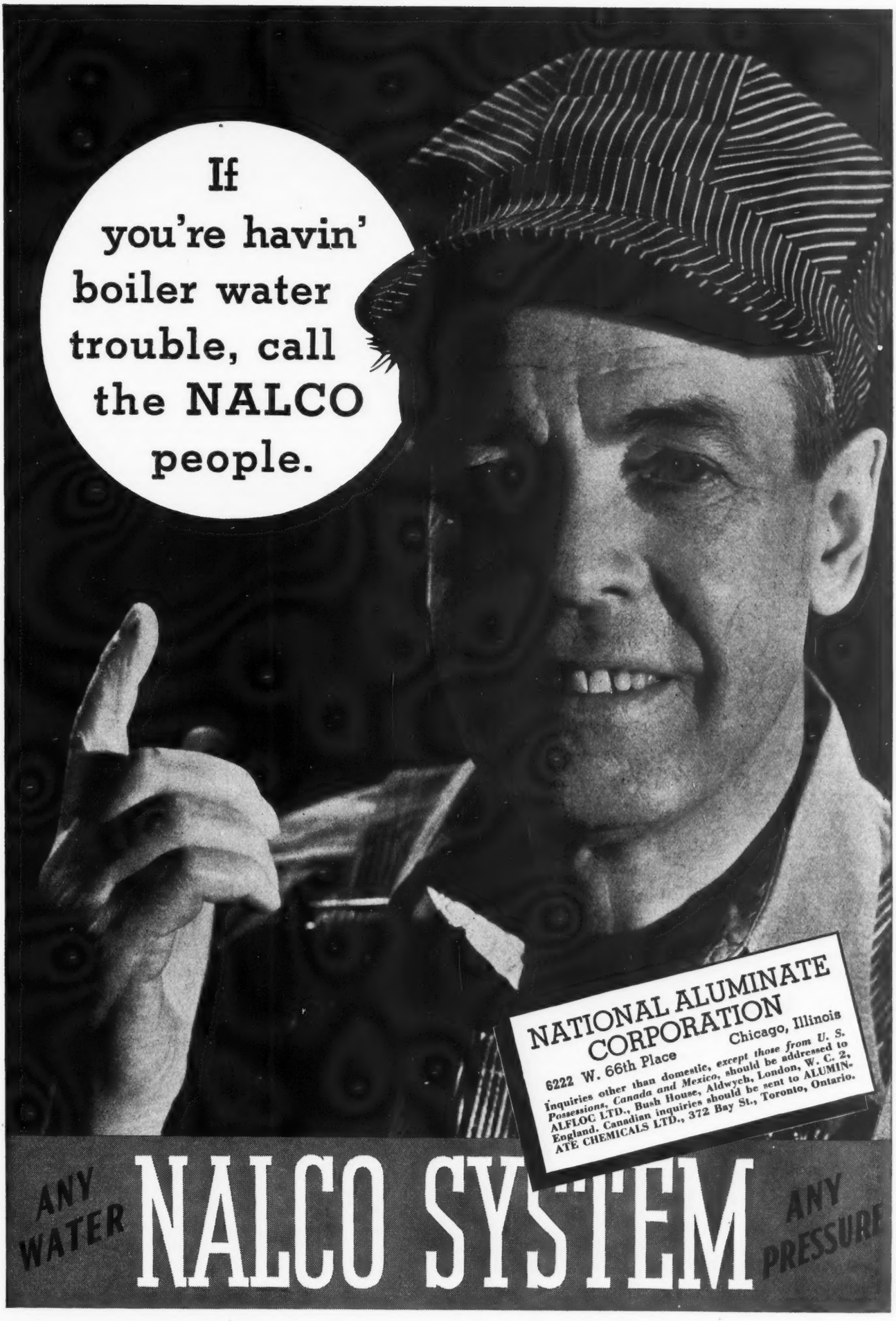
Tenafly, N. J. K B HOFFMAN



Draining Throttle Valves of Process Equipment

WHEN laying out steam-distribution piping for process equipment, designers often fail to provide adequate drainage facilities. This is especially true of branch lines feeding individual units from an overhead main. Throttle-valve drainage in these branches is often omitted, allowing water to accumulate when the valves are closed. Expansion and contraction strains caused by this water seriously affect operation and maintenance. Troubles encountered include leaking threads, loosening of flanged joints and valve leakage. Slugs of water released at high speeds when the throttles are opened may damage equipment.

In one large industrial plant, all throttle valves were tapped for 0.5-in. drain lines, trapped to the condensate-return system. Where process units were located close together with branch piping short enough and of sufficient size to avoid any appreciable difference in pressure at the throttles, it was possible to serve a number of drains with a single trap,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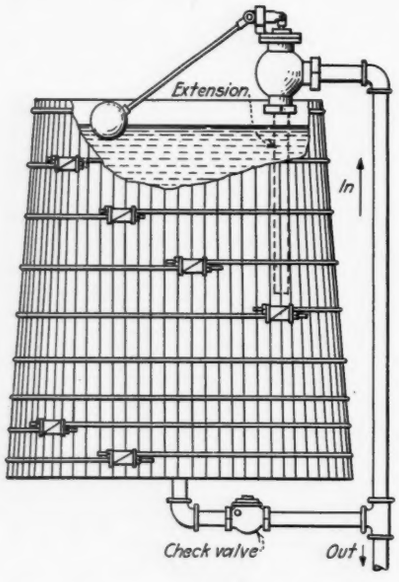
as in the figure. Individual drain lines were equipped with valves to facilitate maintaining the throttle valves, an important factor in preventing heat losses caused by steam leaking into idle equipment.

Lynchburg, Va. O M ROBERTS

Air Troubles in Water Line

TO KEEP down the cost of supplying additional water to a small textile-mill extension, a tank was installed and connected to a single pipeline. This line served the double purpose of connecting the tank to the supply pump and to process, instead of using a line for each purpose. When the equipment went into service, it was found that water flow into the process vats was very unstable, causing inconvenience to attendants.

After some study it was decided



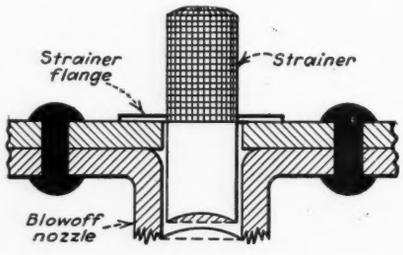
that air was entering the pipeline through the discharge of the float valve, which terminated above the surface of the water in the tank. To correct this condition, we extended a discharge pipe from the valve down into the tank so that its end would always be immersed, as indicated by dotted lines. This device kept flow normal.

New York, N. Y. C W PETERS

Strainer Prevents Plugged Blowoff Lines

LARGE flakes of scale, dislodged by turbine cutters or other scale removing devices, may lodge in blowoff valves and piping of boilers, holding back finer material until the line is stopped up. Removing these obstructions requires much time and effort, as it is often necessary to dismantle the valves or break a number of piping joints to dig or wash out this dirt.

A strainer placed in the blowoff opening of the boiler mud drum, similar to that shown in the drawing, has been used to avoid this trouble. It consists of a sheet metal cylinder that fits tightly into the blowoff opening. A heavy-gage wire screen with a top of the same material is soldered to the cylinder. A circular sheet-



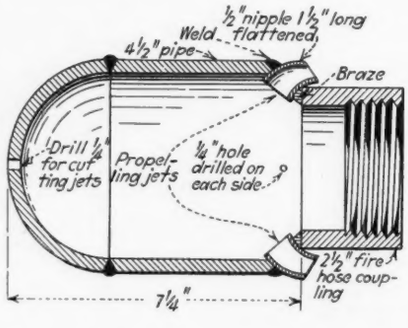
metal flange is fitted to the cylinder where it joins the screen, to prevent the strainer from slipping down into the blowoff line.

Where scale conditions are bad, it may be desirable to make the screen larger than that of the blowoff opening, and solder it to the flange. The flange diameter, however, must never be greater than the circle formed by the inner edges of the blowoff-nozzle rivet heads.

Roanoke, Va. S H COLEMAN

Unstopping Pipelines

FOR unstopping surface drains filled with mud or cinders, the device shown in the figure is a handy tool. It is made from a piece of steel pipe 4.5 in. long with one end welded closed to form a bullet nose, in which is drilled



a small hole for a cutting jet. At the end opposite the nose, three cuts 1.5 in. long are made, equally spaced around the circumference. The three sections are then pushed inward until the end of the pipe has the same outside diameter as a 2.5-in. hose connection. The cuts are then welded up and the hose connection brazed to the pipe.

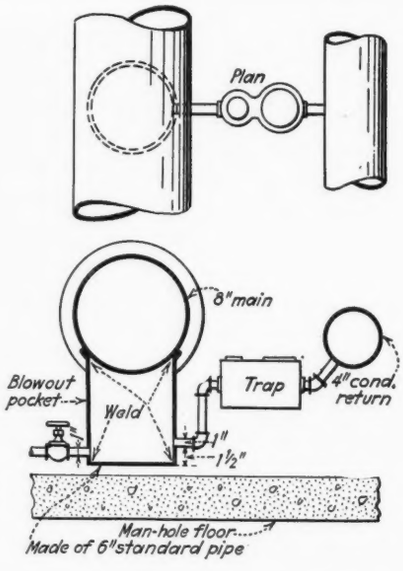
Two propelling jets are formed by welding in two pieces of 0.5-in. pipe as shown, and flattening the ends. On each side, half way between the two propelling jets, a 0.25-in. hole is drilled for a water jet, to prevent the cutter from hugging the sides of a pipeline.

It is only necessary to start the cutter in the stopped-up drain and turn on the water at a pressure of 100 lb per sq in. The head will move into the pipe with a little hose manipulation, and the obstruction will usually be cleared quickly. This cutter may be used in pipelines 8-in. in diameter and larger, but the hose and pipe feeding it must be of ample capacity.

Radford, Va. G R ELDER, JR

Steam-Line Pockets Trap Condensate

OUR district-heating system comprises about 10 miles of mains ranging from 6 to 14 in. in diameter and operated



at pressures of 2 to 15 lb per sq in. There are a few dead ends and the tie connections cause the flow of condensate from line losses to be rather uncertain in direction, because water is sometimes carried upgrade because of high steam velocity. It is therefore necessary to trap condensate from the mains.

Formerly we used small bleeder connections made into the bottom of expension joints and other fittings. This was not entirely satisfactory and we developed the more successful method shown in the diagram. Pockets, made from short lengths of 6-in. pipe, are welded into the bottom of the mains in the manholes. It does not make any difference which direction the condensate may flow, it is caught in one of these pockets and trapped out.

Hibbings, Minn. A L BENNETT

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Off on the right foot, these castings are handled next by Chapman-trained machinists—men who turn out each part to rigid standards of precision. And before any shipment, each part, *each valve* is inspected and tested before it is stamped "O. K."

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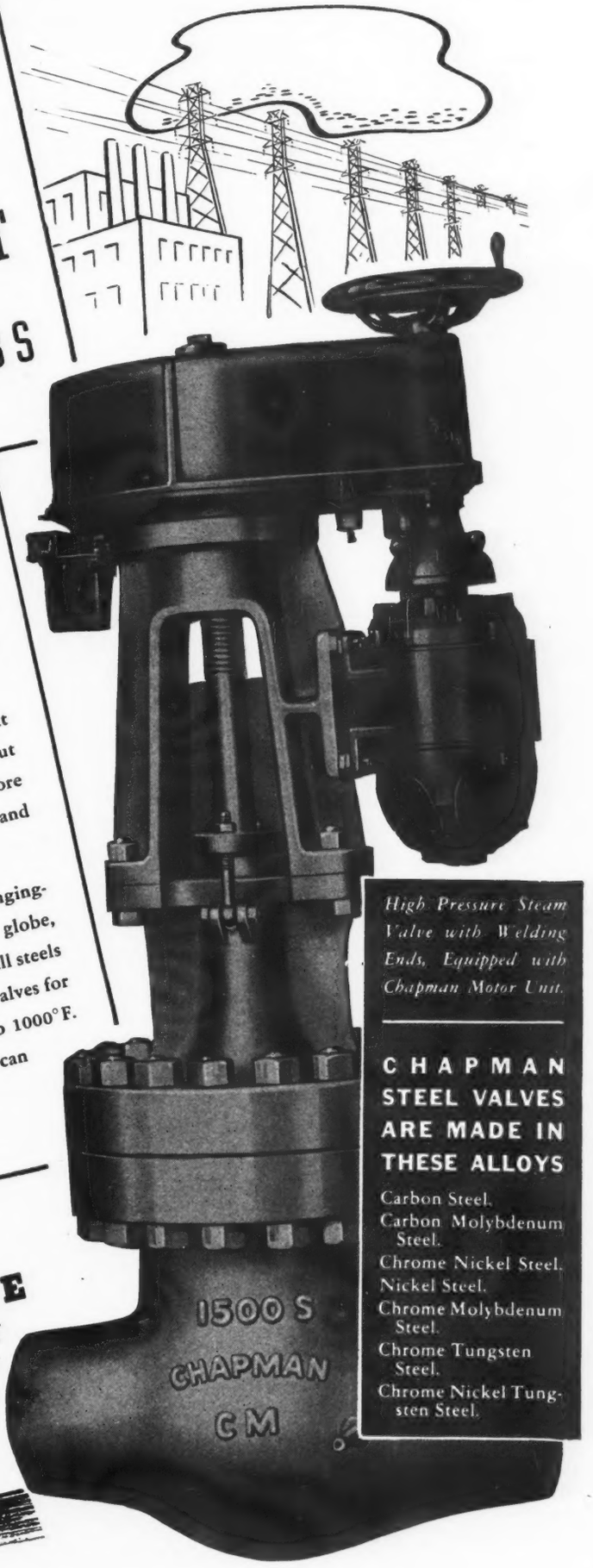

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The **CHAPMAN VALVE**
MANUFACTURING COMPANY
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CURRENT COMMENT

Loosening Coal from Silo Sides

HAVING SPENT many long hours trying to free fine wet coal from silo walls, I read with interest the solutions given in June *Power* for breaking up these formations. Here are a few additional comments. Compressed-air nozzles carefully located along the silo walls offer perhaps the best solution where continued difficulty is encountered from sticking coal, and it is not possible to mix the fine and coarse. After the silo has been built, however, nozzles are difficult and expensive to install.

A cheap and simple arrangement is a short light-weight harpoon made of a 6-ft section of ¾-in. standard copper, brass, or aluminum pipe. This pipe is closed at the bottom end, and two sets of ⅜-in. holes are drilled at right angles through both sides of the pipe near its bottom. The upper end of the pipe is connected to a compressed air hose. A ring is welded to this end and a rope fastened to it, one end of which is secured to the top of the silo.

It has been my experience that a long heavy harpoon is almost useless for loosening fine wet coal. It tends to bury itself without loosening any appreciable amount, and is hard to free after it has been dropped. Being long and heavy, it is also hard to handle.

When the lighter harpoon is dropped in the coal, it buries less. As compressed air is applied through a quick-opening valve at the top of the silo, air jets break the coal loose, causing it to slide down. The harpoon is easily removed to be used again when needed.

Iron should not be used in any part of the harpoon or rope ring. It is likely to come in contact with the concrete walls of the silo and might cause a series of sparks if the harpoon is made of iron or steel.

Waynesboro, Va. J M MYERS

Removing Oil From Pipe Systems

CLEANING OIL out of heating lines (see discussion in the "Reader's Problems" section, page 907, November *Power*), can best be accomplished by boiling out. Take the line out of service when convenient. Isolate it from the system by closing valves or installing blind flanges on extremities of line.

At a point near the line farthest from the engine exhaust, place an open tank of suitable capacity to provide for pump suction and return flow from the line. A small motor-driven centrifugal pump can be mounted close to, or over this tank. Connect the pump discharge into the line to be boiled out.

If no connections are available, the line will have to be tapped and a nipple and valve installed. Make a similar connection at the other end of the line to act as a return to the tank. Hose lengths may be coupled up for a return line if the distance does not warrant piping. At one or more points along the line, connect live steam jets of low pressure. Fill the whole system with water at as high a temperature as possible.

Make a wire-mesh basket lined with Turkish towelling or other filtering medium. This basket is hung in the tank where it can be readily removed for changing of the filter. Fill the tank to at least half capacity with a solution of water and soda ash. Start the circulating pump and, while maintaining the necessary high temperature with the steam jets, continue to add periodically soda ash until results are shown by the amount of oil in the returns.

This procedure carried out for a few hours should show very definite results. Circulation of the solution may be discontinued for a few hours and the boiling maintained, after which time circulation may be resumed. Branch lines may also be treated in this manner, using the same returns.

It is obvious that necessary safety precautions must be observed to avoid any possibility of excess pressure being impressed on the lines. This method is an efficient, economical and safe way of removing oil from the entire system.

Kearney, N. J. GEORGE MCNALLEY

Diesel-Plant Costs in New York

I HAVE read with interest, under the heading of Current Comment in January *Power*, the Consolidated Edison Co's reply to my query in last December's issue.

In my query I made this statement: "With the plant once installed, cost of purchased power must fall practically to the operating costs of the diesel plant, not including fixed charges, before it will pay to shut down.

This whole matter is simply a question of dollars and cents, and what a lot of us would like to know is the comparison in cents per kwhr of the cost of utility power vs. the *purely operating costs* of the diesel plant. It would be out of order to ask the Edison Co what a diesel plant costs, but it would certainly seem reasonable to ask them to give us the cost in cents per kwhr of purchased power to the Sailors Snug Harbor people and to further identify the particular rate schedule under which they are operating. Naturally, I cannot presume to establish the actual cost at present, but assuming that Sailors Snug Harbor is buying current on what seems to be the applicable published rate (Schedule 2, although this rate prohibits residential submetering), a cost estimate of two cents per kwhr cannot be far wrong.

It is inconceivable to me that any of the principals originally connected with the installation of this diesel plant, including the engine manufacturer, would have advocated or even permitted the installation of this plant were the cost of fuel oil, lubricating oil, labor and maintenance to add up to a figure in excess of 1¼ cents per kwhr. The actual operating figure for a plant of this size, age and general design would most probably be about one cent per kwhr, possibly less.

HUXLEY MADEHEIM

New York, N. Y.

Hotel Heating

THE ARTICLES in November and December *Power* by Professor Sayles of Cornell University on hotel heating are timely and interesting. The hotel industry is sadly in the dark on the heat, light and power part of this great business. There is more guess work in this department than in any other branch.

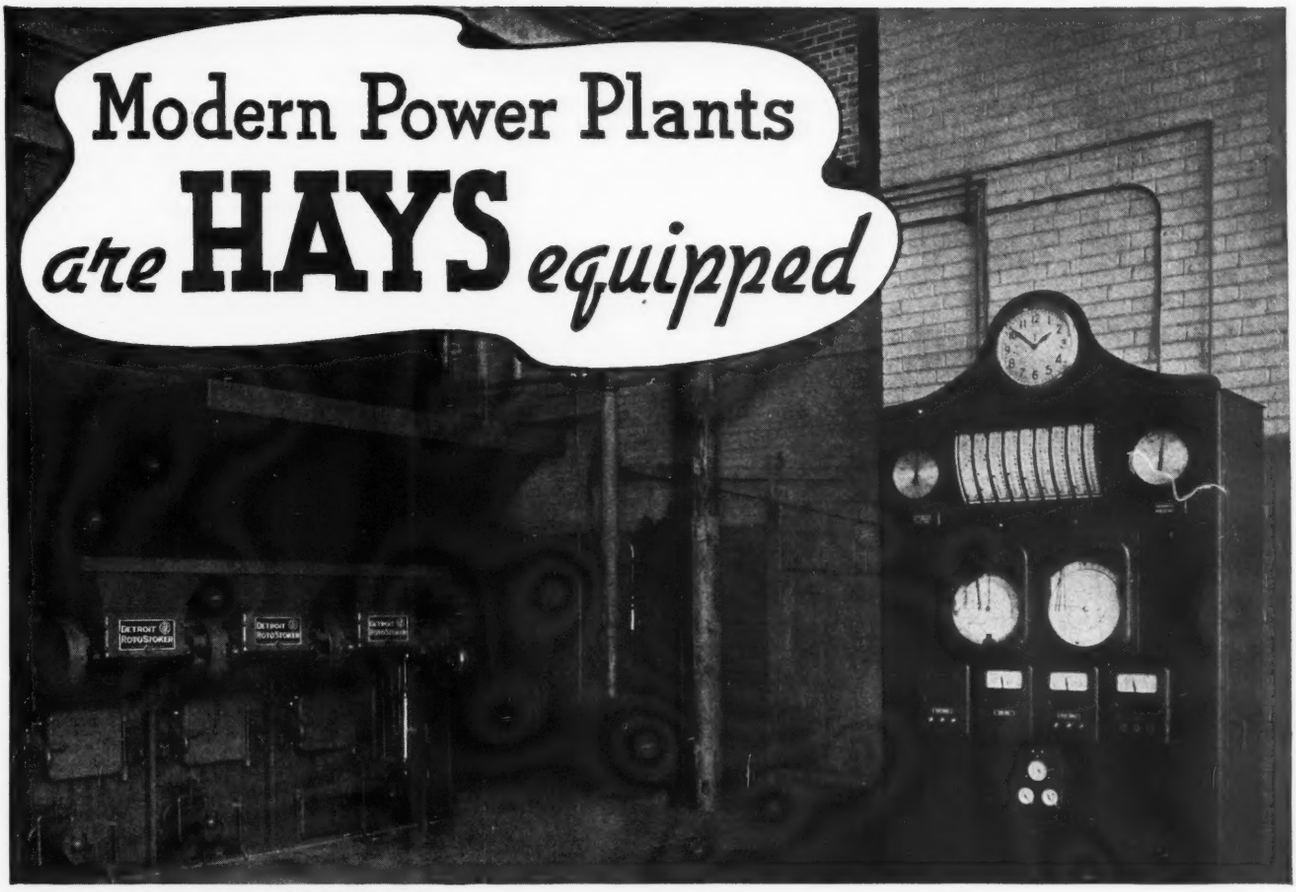
The author's analysis of steam use for building heating is sound, that is, taking into acount volume heated and degree days. However, I fear that the data used in arriving at 0.97 lb per 1000 cu ft per deg-day may be in error due to the amount of guess work in this part of the hotel business. For example, cubage figures given by architects may take in everything from the bottom of foundation footings to the top of parapet walls in order to arrive at a low construction cost per cubic foot. One hotel, reported as 3,926,000 cu ft by the architect, has a net heated volume of 2,535,000 cu ft, 64% of the stated figure.

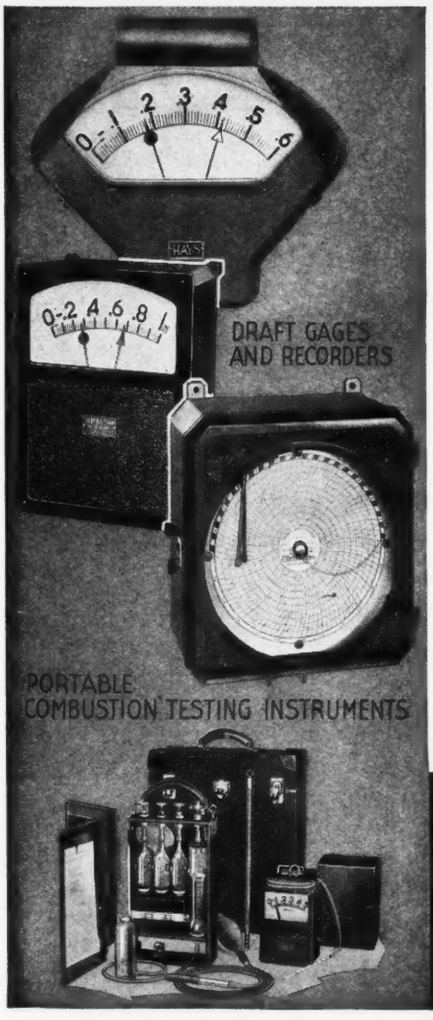
Heating figures can be in error also when steam is purchased. Separate metering of heating steam and other services is not frequent. In examining Table 1 of the December article, it appears that the 0.97 figure was derived from 10 hotels rather than 40 and that these ten range from 0.668 to 1.31 lb, a variation of 100%. Embarrassment might follow too literal application of the 0.97 figure as a yardstick.

To illustrate wide differences in hotel costs for heat, light and power, a comparison of costs of two of our largest and finest hotels show $61.64 per room for one as against $144.84 for the other. The former produces all of its heat, light and power in its own plant while the latter purchases electricity and steam. Correction for climatic conditions has not been made, since the slight difference is in favor of the latter property. While no fixed charges have been made for the power plant in the one case, the annual difference in cost of the services represents about 50% of the estimated cost of power plant and equipment.

New York, N. Y. EGBERT DOUGLAS

Modern Power Plants are HAYS equipped





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READERS' PROBLEMS

QUESTIONS for Our Readers

Commutator Black Spots
Question 1

WE OPERATE *three 100-kw, 3-wire, compound-wound, 220-volt dc generators. One of them developed a burned commutator which we trued up. After 6 months, the burned spots are developing again. The spots are three bars wide, tapering off to nothing in about six more bars.*

There are six sets of brushes on the machine and the burned spots occur at three places spaced equally around the commutator. Can some POWER *readers tell me what the cause of this trouble may be?*—GCC.

Selecting Paint
Question 2

OUR PLANT *has a great many windows which are steel sash. In the winter months, so much steam is given off in the plant by warming pans that the windowpanes and sash are continually wet. We have had to repaint frequently due to rust on the sash. We use ordinary black paint and have not previously tried to get off the old paint which is now peeling and cracking badly. This year we are going to scrape off the old paint and start over again.*

Can POWER *readers suggest the best method of getting the old paint off and whether a coat of red lead and then ordinary black paint is the best that can be done, or is there some special paint that will last longer?*—ECM.

Suitable answers from readers will be paid for if space is available for publication.

COAL BUNKER OUTLET

Answers to December Question 1

The Question

WE HAVE *a large bunker for overhead storage of coal with down spouts leading to individual stokers. We use a steam coal graded 1½ in. and under. Often this coal is predominately fine and when shipped in rainy weather or when outside temperature is below freezing, coal has been known to stand with almost vertical faces. In some cases, a small round hole will drop all the way through the 20-ft depth of coal in the bunker. In any event, coal flow is interrupted and the fireman has to use hand methods to reestablish coal flow.*

The first shift engineer has suggested an elongated hopper to replace the single 12-in. outlet opening. This hopper would have three 18 x 18-in. openings to the bunker. Stresses in the steel bunker plate would be taken up by welding a heavy webbed-steel plate which would be the attachment plate between hopper and bunker. And instead of having a single outlet opening in the bottom of the bunker, there would be three such openings in line, which would have a tendency to avoid a cylindrical hole and its tendency for coal arching. Before investing money in this proposed revision, I thought that POWER *readers might be able to help us with a problem that is very aggravating a few weeks each year.*—HHL.

Should Have Agitator in Combining Hopper

IF HHL follows his plan, adjoining holes will form in the solid body of the coal, combining into one large hole by the collapse of the coal-forming partitions between the holes. The larger hole would give less stability to the near-vertical walls of coal and would be a decided improvement over the present condition.

The disadvantage of the scheme is that it requires a combining hopper of sloping sides against which an arch will form in the gate in the spout. To offset this, there should be an agitator in the hopper, actuated from the firing floor. Such an agitator should be substantial and carried in a solid bearing on each side to prevent binding or jamming as increasing load in the bunker distorts the plate construction of the hopper.

If hopper or bunker were of non-yielding construction (cast iron or concrete), an agitator would break down arching, permitting coal to issue freely, and weakening the walls of the larger hole in the compacted body in the bunker.

The case of HHL proves that discharge efficiency of coal bunkers has been more or less ignored. What is called a bunker is often no better than a tub, from which coal issues at the gates only, trimming being required to dislodge coal from the space between the gates.

Brooklyn, N. Y. J. VAN DYK

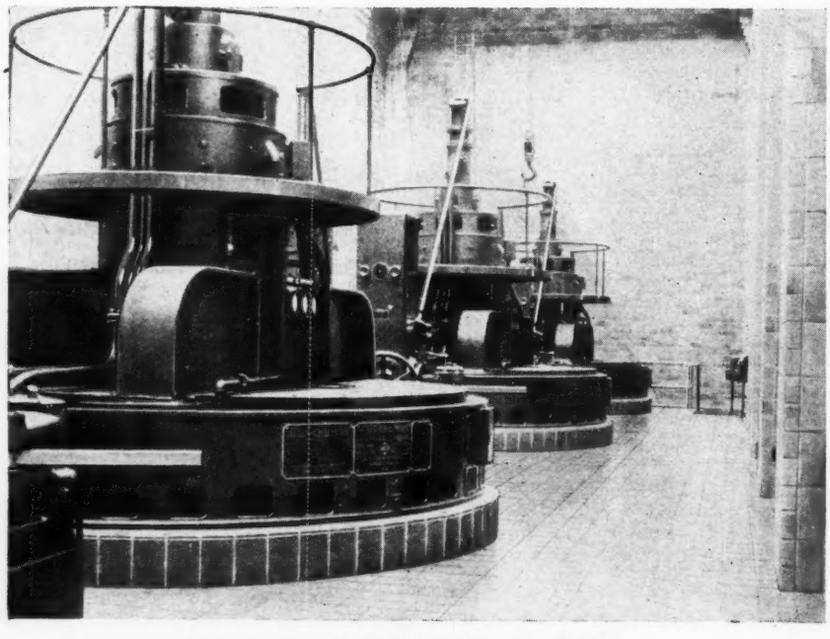
Try Vibrators First

REFERRING to Question 1, December *Power*, I suggest that mechanical vibrators be tried before making any expensive alterations. There are vibrators on the market for just such purposes, and in general they do very well.

Atlantic Highlands, N. J.
M M GOOCH

Increase Slope of Hopper Sides

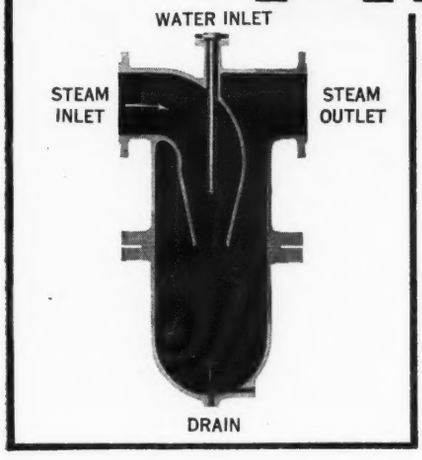
THE COAL bunker described by HHL is typical of many structures designed by men with no previous experience in handling or using the material to be stored. With a bottom as originally furnished, anyone—save perhaps a desk-bowed



NEW HYDRO PLANT AT SPOKANE, WASH.

Interior view of up-river powerhouse on Spokane River built by City of Spokane, Wash., under direction of Alex Lindsay, supt of waterworks. The station contains three Allis-Chalmers generating units with Kaplan propeller-type turbines, each rated 1,800 hp, 200 rpm, 33-ft head

ATOMIZED



The upper picture shows the top half of a CARBURETOR TYPE Desuperheater, as set up for demonstration purposes. A small stream of water admitted thru the water inlet nozzle, is finely atomized by compressed air entering thru the superheated steam inlet.

The lower picture is a sectional view of the desuperheater itself. Extremely simple, and equally effective.

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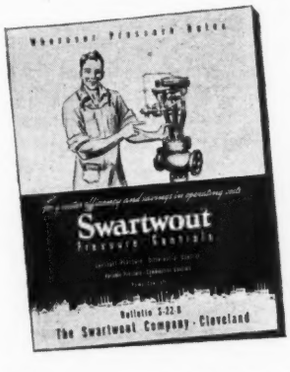

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The incoming cooling water is instantly converted into a fine mist—the same principle as used in automobile carburetors—and is immediately evaporated by the superheated steam. The cooling is uniform and positive.

Swartwout builds your complete desuperheating installation according to your requirements, and provides safety features such as these:

(1) If desuperheating water fails, entire station is shut down.
(2) High pressure supply is prevented from being pulled down below a certain predetermined point.
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Power engineers approve this tried and tested Swartwout Desuperheater system in principal industries in this country and abroad.

Give us complete details of your desuperheating problem. Don't risk plant shut-downs or crippled equipment. Let us present our recommendation on a desuperheating station. Or write today for Bulletins S-21-A and S-100 F.

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PARKER POWER

Trashrack structures which will protect the power penstocks at Parker Dam, about 150 miles below Boulder Dam on the Colorado River. An expected capacity of 125,000 hp is to be installed—Wide World Photo

draftsman—would know that only a relatively small cone of fuel could flow by gravity to the stoker feed pipe through a 12-in. opening.

The angle of repose for coal such as HHL was using is given by various authorities as from 30 to a possible 45 deg, though an observation of open or yard storage will show that the slope of gravity-piled coal is greater than 1 on 1, or 45 deg. For this reason, in the hopper sketched by HHL, with sides sloping at 45 degrees, coal is apt to clog and bridge in the hopper, forming a shut-off which would require manual opening.

If the slope is changed to 60 deg, the danger of bridging with wet or cold (but not frozen) coal will be avoided. However, the two cross members at bunker-base level will tend to encourage bridging and should be eliminated, if possible, by strengthening on the outside. If a brace must be included in the throat, it should be of triangular section with the apex upward, or, at worst, a round bar, welded in place.

Due to the angle of repose, the bottom of the bunker lying at each side of the opening is dead storage, from which coal can be removed only by sending a man into the bunker with a shovel or rake. Extending the sides of the hopper upwards into the bunker will insure satisfactory feeding, even though reducing the theoretical capacity of the bunker. If the adjoining stoker leads lie close enough together to make it feasible, the sides of the adjoining hopper extensions could be continued until they meet, practically eliminating all dead storage at the bunker base.

Kilgore, Texas C C LYNDE

MOTOR-GENERATOR SET

Answers to December Question 2

The Question

A MOTOR-GENERATOR *set, made up of a 130-volt dc shunt generator direct connected to a 3-phase, 25-cycle, 220-volt induction motor, has been acting up on me. When any voltage drop or line trouble occurs, the set will blow the dc fuses. Also, if excitation be reduced so that the battery is discharging, and if the dc-generator switch is pulled and then thrown in, the generator will show a charge of 10 amps and excitation is similar to that with a discharge current. Apparently, polarity is being reversed when a line interruption occurs, which causes the generator to become a motor and blow the fuses. Why aren't fuses blown on low excitation and when the dc switch is pulled? Is the generator oversensitive? Would shifting the brushes overcome the trouble?*—LHK.

Five Possible Causes for the Trouble

SEVERAL causes for LHK's difficulty with the motor-generator set come to mind, all of which are the result of experience with this class of equipment.

1. Motor-generator is made up of two machines of different speed, as for example, an 860-rpm motor and a 500-rpm generator.

2. Conductors between battery and load are too small, or poor connectors are preventing the battery from taking load surges when voltage drops because of heavy load.

3. Field-rheostat resistance steps between contacts are too large.

4. Better results can be obtained if shims are removed from between field poles and frame to increase air gap. I have enlarged field-pole bore by machining off pole faces when there were no shims back of polepieces, and then adding shims until I got the results I wanted.

5. Motor speed drops because of loose squirrel-cage connections, low voltage, low frequency, or poorly reconnected windings.

N Bergen, N. J. OTTO SCHOLL

Fuse Location and Size May Be Incorrect

SINCE LHK has not included a connection diagram with his question, it is difficult to analyze accurately his problem. One solution might be that the fuse location and size are not correct.

If under normal operation, the generator supplies current to a load with the battery floating on the line, battery fuses would only have to take care of the charging current. When the generator is shut down, the battery would then supply all load current required and the battery fuses would have to carry this current. When the motor is without power because of line failure, the generator takes current from the battery which also supplies the load current required. These two currents may be greater than the capacity of the fuses and cause them to blow.

With low excitation at the generator, the difference in voltage between the generator and battery may not be great enough to cause sufficient current to flow from the battery to blow the present size fuses. The greater this difference, the larger the current flow from battery to generator required to operate it as a motor. Replacing the present fuses with larger ones, or changing fuse location, or perhaps both, will probably remedy the trouble.

University, La. G F MATTHES
Louisiana State University

AC Line Trouble May Blow Fuses

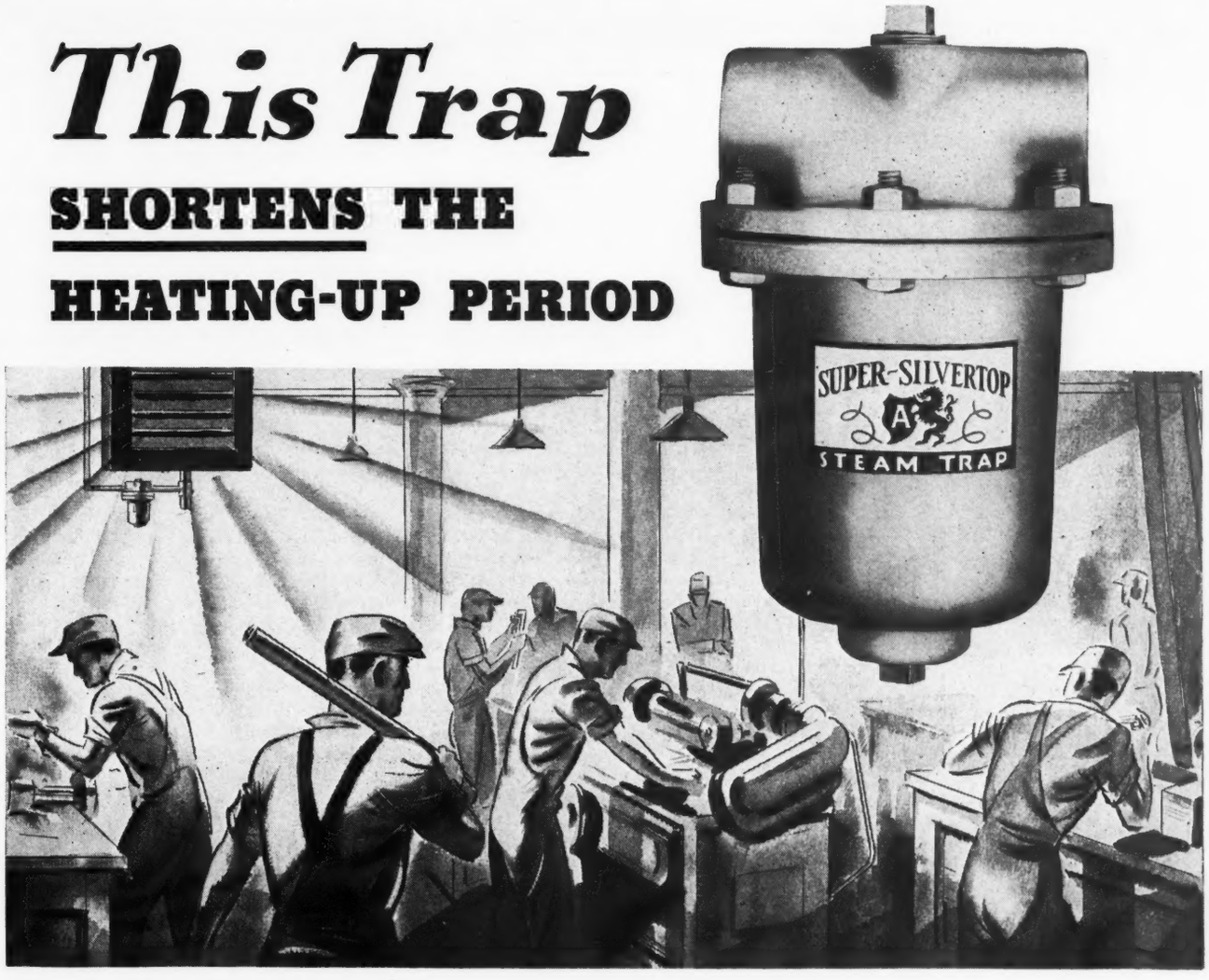
A SHUNT GENERATOR, if connected to a supply line or battery, will act as a generator and deliver current whenever its voltage is higher than that of the line or battery, and will act as a motor receiving current when its voltage is below that of the line. This action is entirely automatic, and there is no change either in polarity of the machine, or in current direction in the shunt field, but only a reversal of armature current.

When trouble occurs on the ac line and the motor does not receive its proper current, motor-generator speed drops and de-generator voltage falls until it becomes a motor and drives the motor-generator by current taken from the battery.

Trouble on the ac-supply line causes a lower frequency or a reduction in line voltage. The induction motor then becomes an induction generator furnishing current to the power line, but is driven

This Trap

SHORTENS THE HEATING-UP PERIOD



● When a cold pipe coil, unit heater or other steam using unit must be heated up, that is the time when maximum heat is most desired. When such a unit is trapped with an Anderson Super-Silvertop, the unit instantly becomes hot as soon as steam enters the system. It stays hot, at maximum heat all day long, because Anderson Super-Silvertops remove all the air as well as all the condensate. Instant, maximum heat shortens the heating-up period.

When steam in a system is mixed with air, the air acts as insulation for the heating surface. Anderson Super-Silvertop traps by removing all such air make available the full value of heat in the steam.

Other features of Anderson Super-Silvertop steam traps are unusually high condensate capacity (compare the different trap capacities); simplified piping (connected either as elbow or straight-in-line); works on pressure or vacuum (proof that trap does not leak steam); produces more heat from steam systems because of complete air and condensate removal.

Find out more about how to get faster heat . . . write for full information about Anderson Super-Silvertop, the only complete steam trap.

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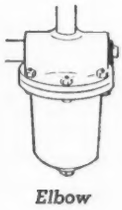
Straight-In-Line

SUPER-SILVERTOP STEAM TRAPS



Elbow

by the dc generator through current taken from the battery. If this current is excessive, dc fuses will blow.

To supply normal charging current to the battery requires a high voltage and consequently, high excitation. As excitation is decreased, generator voltage and battery current decrease until the battery floats on the line. Further voltage reduction causes the battery to discharge, and if carried far enough, will blow the dc fuses.

If the generator is directly connected to the battery, over-all efficiency is high, but the machine may be oversensitive. If the generator has sufficient voltage margin, it is advisable to charge through some resistance, which will make equipment more stable, although efficiency is somewhat reduced.

New York, N. Y. HORACE DOWIE
Electrical Engineer

Try Automatic-Voltage Regulation

I DON'T believe that this generator is any more sensitive than is characteristic of a shunt machine. A compound machine would probably give more satisfactory service, but the situation can be corrected by installing an automatic voltage regulator.

Shifting the brushes would probably not improve conditions. If there is no arcing, brushes should be left alone. The change in regulation by shifting the brushes is very slight.

WM. ROHRHURST
Bound Brook, N. J.

Generator Not Oversensitive

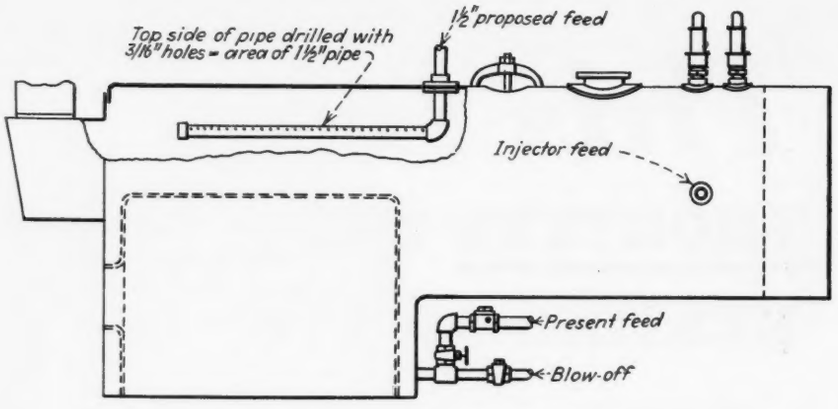
I DO NOT think that the generator is oversensitive, although it may be a little slow in building up. Proper brush setting is as near as possible to the point of sparkless commutation, which point need not be changed, once determined. The manufacturer may have the rocker arm position marked, and it would be well to set the brushes accordingly.

Do not reduce generator voltage below that of battery with dc-generator switch closed. If battery becomes fully charged, cut out generator entirely for a while, or reduce charging rate slightly. Operation along these lines should eliminate irregular operation.

Chillicothe, Mo. L N WEAVER

Prevention of Pitting in an HRT Boiler

THE DIAGRAM *shows boiler-feed-piping arrangement in our plant and proposed change in it to overcome corrosive effect of excessive oxygen and other gases. This boiler has 960 sq ft of heating surface and is designed for 125-lb working pressure. Water supply for makeup, coming from a water shed where there is a quick runoff, flows through rotting timber and decomposed vegetable matter to a small storage reservoir and is agitated as it enters the pipeline. This water can be classified as very soft, because after 2.5 years of operation, there is practically no scale in the boiler. A recent wash-out and inspection disclosed that pitting action is developing at bottom of the tube sheet near the foundation ring at flange knuckle and also in the throat sheet around hand-hole plates.*



I would like an opinion of the arrangement of the proposed new feed pipe as shown in the diagram. We propose to place the feed pipe on a level with the lower end of the water column. Would there be any detrimental effect on hot tube surfaces with this arrangement? This boiler is never operated at high ratings. 50% of feedwater is return condensate delivered to hot well at about 170 F by vacuum pump.

I have been feeding 2 lb of soda ash a week until now, but as scale has started to form; this treatment has been discontinued and the period between blowdown has been increased. We are consulting a feedwater specialist as to water treatment, but would like advice as to changes of feed piping and their relation to the promotion of corrosive action—EBW.

Three Methods for Stopping Corrosion

THE practice of feeding water to a steam boiler through blowdown piping is usually accompanied by difficulties. Acceleration of corrosion by oxygen and other gases becomes localized near the point of feedwater discharge. Feed water is discharged so far from the steam space that little dissolved oxygen finds its way to the water level to escape with steam flow, and instead reacts on the boiler surfaces below the water line. If this plant is of such a size and design that an open feedwater heater for dearation is impracticable and oxygen content of feedwater is high, several other things can be tried to reduce pitting and corrosion.

First, feedwater should enter the boiler through the top of the boiler. The discharge piping should be turned towards the rear, as there is some danger of precipitation of solids onto the crown sheet, if the discharge is installed as shown. Overheating of the crown sheet might then result.

Locate discharge pipe several inches above the level of the upper gage cock, and offset it so that it won't be directly under the manhole or steam nozzle. Keep it at least 6 in. away from any riveted seam. A sheet baffle installed over the perforation will help to prevent spray-priming with the steam flow. Such a discharge of feedwater allows much of the corrosive gas to pass out of the boiler with the steam. Corrosive action is no longer localized on limited surfaces where its penetration rate may cause serious results in a short time.

Protective Coating

As a second preventative measure, provide a protective coating on all internal, water-heating surfaces. Obviously, it is not practicable to do this by painting in this type of boiler, but can easily be done by lime treatment. About 16 lb of lime should be sufficient for this size boiler, 8 lb of which should be slaked in water and introduced through the manhole into the boiler, when water level is normal. On each day of operation thereafter, for four days, 2 lb of lime should be slaked in water and fed into the boiler. Amount of blowdown should be kept to a minimum in order to allow the lime to set, except in case of emergency.

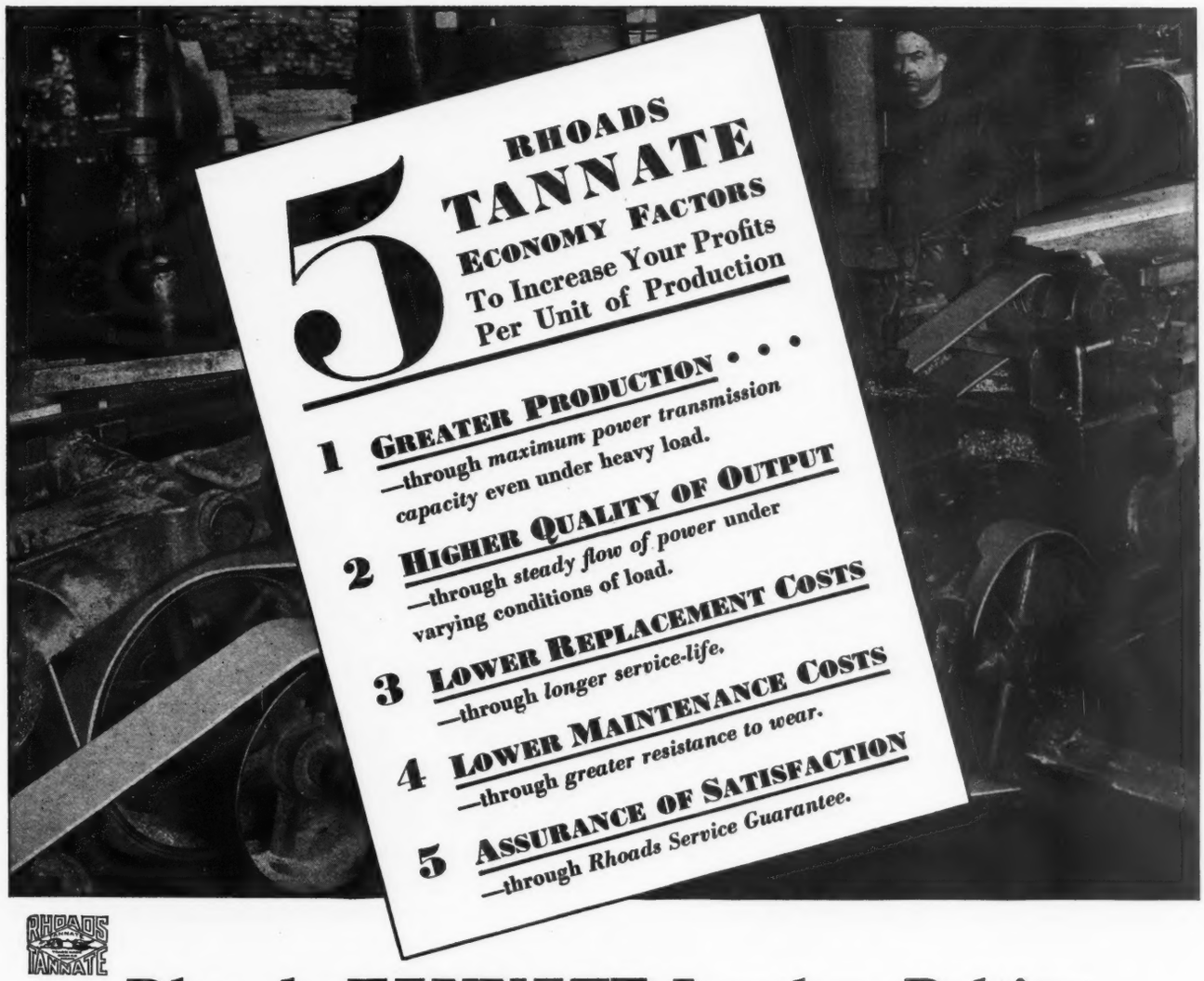
This treatment may be repeated at intervals of 6 months to one year if necessary, to maintain a coating of paper thickness that will not materially affect boiler efficiency. It will, however, retard pitting and corrosion by preventing direct contact between the hot surfaces and oxygen-bearing water. It has been used in many cases with complete satisfaction.

Third Method

A third method of reducing oxygen content is to pass the makeup water over large surfaces of scrap iron in a low-pressure tank. This practice, known as deactivation, removes oxygen by oxidizing the scrap iron surfaces which corrode and pit, instead of the boiler.

Cleveland, O. A C WIGGINS

He that wrestles with us strengthens our nerves and sharpens our skill—our antagonist is our helper. —*Burke*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1 GREATER PRODUCTION • • •
—through maximum power transmission capacity even under heavy load.
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—through steady flow of power under varying conditions of load.
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TANNATE LEATHER BELTING

LOWERS COSTS Per Unit of Production

PRODDER, NOT PLODDER . . .

THE new chief was taking his first official stroll down through a big central station, when back of a boiler he spied an ancient Irishman seated comfortably on his barrow, puffing at his pipe. The chief felt that he ought to impress Paddy with his importance, so he walked up and said, "What are you doing?"

"Shmokin' me pipe, ye dum phule!" said Paddy. "And phwhat are ye doin'?"

"Looking over the plant," said the chief. "What's your job?"

"Pray, and that's mine and me boss' affair!" said Paddy. "If ye must know, tell me first what's yours?"

"I'm the new chief engineer!"

Paddy took a long, slow drag at his pipe while he thought that over. "Faith, then, ye'd better be about it!" he said. "That's a good job, and if ye want to keep it, ye'd better be wurrukin' at it!"

That chief learned something right there. From then on, he minded his own job, leaving to others the minding of theirs. Paddy was responsible to a foreman; if he didn't work, the place to start checking was with the shift engineer and the foreman, not with Paddy.

A chief I know has his own method for keeping his men awake and at work during routine operation. He walks up to a foreman or shift engineer once a day or so and says, "How's everything going?" or "Are we up to schedule?" That serves two purposes: First, it prods the foreman to check to see how things are going, and if not, why not. Second, it prods him to think of new and better ways to do things, so he'll have something sensible to say on the chief's next trip around.

It helps the chief too. His big job is training his men so they'll know how to handle whatever happens. If he does all the managing, all the thinking, the foremen and shift engineers soon let him do it. Instead of training prodders, he trains plodders, and the exceptional man beneath him (or outside) who is a prodder will soon take his place.

George Edwards

Engineer

Ready to Fill RUSH ORDERS..

..WITH GEARS THAT STAND THE GAFF

● *Cast iron gears from this stock maintained by Boston Gear Works of Quincy, Mass., are employed in a wide variety of applications. To successfully meet such requirements, the Boston Gear Works specifies Nickel for all warehouse stocks of cast iron gears.*

Twenty-four hour service on 90 to 95% of stock orders for cast iron gears, necessitates a large assortment of gear and teeth dimensions in the warehouse stock shown above. And service in printing presses, power shovels, hoists, conveyors or tractors, demands the selection of gears that are *right*, for each individual job. . . . In planning to meet such widely varying requirements from stock, the Boston Gear Works of Quincy, Mass., relies upon Nickel. Data on service conditions is frequently lacking. Yet every gear shipped must stand up in service. So this manufacturer plays safe—builds strength, toughness and wear resistance into *every* stock cast iron gear by using Nickel compositions.

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The use of Nickel in cast iron gears affords numerous advantages. Boston Gear Works has found that Nickel aids machinability by reducing the formation of chilled corners at thin edges and sections. Moreover, porosity is reduced in heavy sections, thus avoiding those costly rejections encountered with plain iron when porosity in the gear blank is discovered after a portion of the machining operation has been completed.

A typical composition supplied by this firm in gears of moderate section size is as follows:

Total carbon	3.20/3.50%
Silicon	1.50/1.70%
Manganese	.60/ .80%
Nickel	1.00/1.25%
(Steel in charge)	30%

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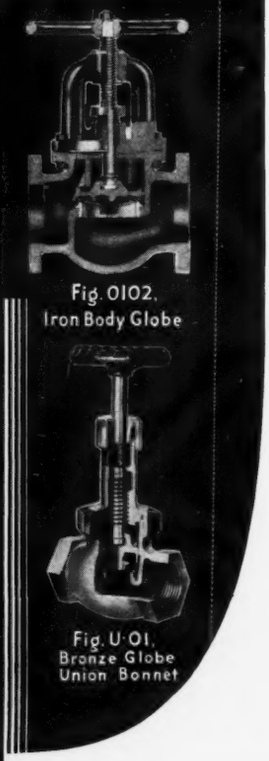

STRAWS (Continued)

asked early in spring. Cost about $200,000. Ernest Sibley, Litchfield, architect.

COLORADO — Briggsdale plans rebuilding of portion of municipal power plant, recently destroyed by fire.

FLORIDA — Apte Brothers Canning Co, Miami, plans boiler plant at proposed new branch fruit-canning plant at Mansura, La. Cost about $50,000.

West Florida Electric Co-Operative Assn, Inc, Graceville, plans electric plant for rural electric system. Cost about $30,000. A J Crutchfield, president.

Duval County Welfare Board, Jacksonville, plans addition to steam power house at county hospital, including new boiler units and auxiliaries. $257,000 through Federal aid for entire project.

GEORGIA — Thomasville contracted B L Bickerton & Son, 504 South Hansel St, Atlanta, for addition to municipal power plant, exclusive of equipment. Cost over $60,000. Weideman & Singleton, Atlanta, consulting engineers.

Coca-Cola Co, Atlanta, plans steam power house at new syrup-manufacturing and mechanical-bottling plant, Dallas, Tex. Robert & Co, Bona Allen Bldg, Atlanta, architects and engineers.

ILLINOIS — Fulton Market Cold Storage Co, 1000 W Fulton St, Chicago, contracted William Mavor Co, 7 South Dearborn St, for improvements in cold-storage plant. R E Pingrey, 205 W Wacker Dr, architect. Cost about $30,000.

IOWA — Sioux City Gas & Elect Co, Sioux City, has arranged for purchase of controlling interest in Yankton Gas Co., Yankton, S.D., and will convert property from artificial to natural gas. New welded-steel pipeline will be built.

Board of Education, Muscatine, plans central-heating plant in new 3-story high school, for which bids on general contract will be asked at early date. Cost about $500,000. Keffer & Jones, Masonic Temple Bldg, Des Moines, architects.

Interstate Power Co, Dubuque, plans rebuilding of electric power plant at Elgin, used for standby service, recently damaged by fire. Loss estimated about $40,000.

Des Moines Ice & Fuel Co, 100 Maple St, Des Moines, plans extensions in pumping station at 800 New York Ave, to include 150,000-gal. steel storage tank and other equipment. Cost close to $30,000.

KANSAS — State Board of Administration, State House, Topeka, contracted U. S. Engrg Co, 914 Campbell St, Kansas City, Mo., for equipment for power house at U of Kansas Hospital, Kansas City, at $22,000; also let contract to Universal Construction Co, Hall Bldg, Kansas City, Mo., for improvements in power house at $33,333. T I Nall, State House, Topeka, state architect.

St Francis contracted J F Wayland Bridge Co, Washington, at $80,241, for extensions in municipal power plant, including 1-story addition, 39 x 69 ft, and two diesel generator units, 400-hp and 300-hp capacity, respectively. E T Archer & Co, New England Bldg, Kansas City, Mo., consulting engineers.

KENTUCKY — Louisville will place contracts soon for pumping machinery and auxiliaries for extensions in municipal pumping plant. Cost about $160,000. Alvord, Burdick & Howson, 20 North Wacker Dr, Chicago, consulting engineers.

Fayette County School Board, Lexington, D Y Dunn, Supt of Schools, plans central-heating plant in new 2-story high school on Harrodsburg Pike, for which bids will be asked early in April. Cost about $250,000. J T Gillig, Walton Bldg, Lexington, architect.

Louisville Water Co closed bids Jan 10 for four 15,000-gpd, 200-ft-head, vertical, motor-driven pumping units, four 24-in. automatic cone valves, and three drainage pumps. Alord, Burdick & Howson, Chicago, engineers.

LOUISIANA — Jennings Refining Co, Jennings, plans power house at new oil refinery at Jennings. Cost close to $90,000.

Board of Administrators, Charity Hospital

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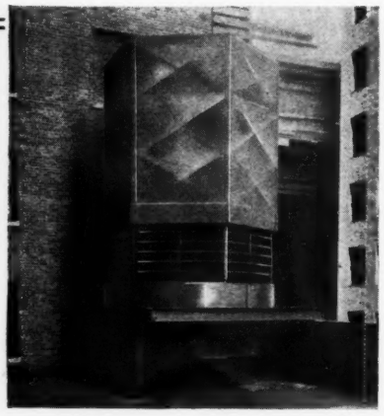

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of Louisiana, New Orleans, F W Matthews, secretary, will award contract soon for steam power house and refrigerating plant at new charity hospital. Cost over $100,000. Weiss, Dreyfous & Seiferth, Maison Blanche Bldg, New Orleans, architects.

MASSACHUSETTS — Holliston Water Co, Holliston, plans early rebuilding of main water-pumping station on Washington St, recently destroyed by fire. Loss about $55,000.

Marblehead will add a 754-kw, Alco-Sulzer, 6-cyl, 277-rpm diesel-generating unit to municipal lighting plant. Engine will be similar in general design to 8-cyl unit recently added at Hudson.

MICHIGAN — Bergland Lumber Co, Ewen, plans boiler house in connection with rebuilding of mill, recently destroyed by fire. Loss estimated close to $200,000.

Public Lighting Dept, Detroit, has arranged fund of $456,000 for electrification of new sewage-disposal works and extensions in municipal power station. L J Schrenk, lighting superintendent.

Board of Education, Detroit, plans central-heating plant in new 3-story high school in northwestern part of city. $912,000 authorized.

Paw Paw is considering rebuilding of municipal hydroelectric plant recently destroyed by flood waters. Cost of replacement estimated at close to $100,000.

Construction Service, Veterans' Administration, Washington, D. C., contracted Cooper-Little Co, Maccabees Bldg, Detroit, for boiler plant, elevated steel tank and tower, and garage building at new hospital at Dearborn, at $189,000.

MINNESOTA — Anoka has preliminary plans under way for municipal hydroelectric plant. G M Orr & Co, Baker Arcade Bldg, Minneapolis, consulting engineers.

Bemidji Wood Products Co, Bemidji, is considering new boiler house in connection with rebuilding portion of sawmill and woodworking plant, recently destroyed by fire. Cost about $70,000.

St. Paul, contracted Perry Swenson Const Co, Minnesota Mutual Life Bldg, St. Paul, for two pumping plants for sewage system, $30,000.

Stella Cheese Co, Metropolitan Bank Bldg, St. Paul, plans new boiler house, 40 x 50 ft, at branch plant at Clayton, Minn., to include two 1500-sq ft boiler units and auxiliaries. Also plans air-conditioning system at Baltic. Both projects will cost about $75,000. R W Richardson, Oppenheim Bldg, St. Paul, consulting engineer.

Sleepy Eye contracted Fairbanks, Morse & Co, Chicago, for diesel-generator unit and auxiliaries, at $82,751. G M Orr & Co, Baker Arcade Bldg, Minneapolis, Minn., consulting engineer.

Owatonna plans large motor-driven pumping station in connection with new sewage-disposal plant, for which $250,000 has been arranged. Buell & Winter Engrg Co, Insurance Exchange Bldg, Sioux City, Iowa, consulting engineer.

Boote's Hatcheries & Packing Co, Worthington, plans 1-story cold-storage and refrigerating plant at local meat-packing plant. Cost about $50,000. J C Boote, president.

Board of Education, Stillwater, plans central-heating plant for new junior high and grade schools. Cost about $400,000.

Two Harbors will soon place award for a 5000-sq ft boiler and auxiliary equipment for municipal power station.

MISSISSIPPI — Southern Package Corp, Port Gibson, plans boiler house in connection with rebuilding of portion of veneer mill, recently destroyed by fire. Cost over $85,000.

MISSOURI — Rockport contracted T L Dawson, 2035 Washington St, Kansas City, Mo., for municipal power plant at $106,710, to include three diesel-generator units of 975 hp total rating, fuel oil tank and auxiliaries. Engineering Service Co, Railway Exchange Bldg, Kansas City, consulting engineer.

Chillicothe will soon make awards for improvements in municipal power plant, including contracts for a 2500-kw steam turbine-generator and accessories, and 4300-

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and compressors air
free of abrasive dust
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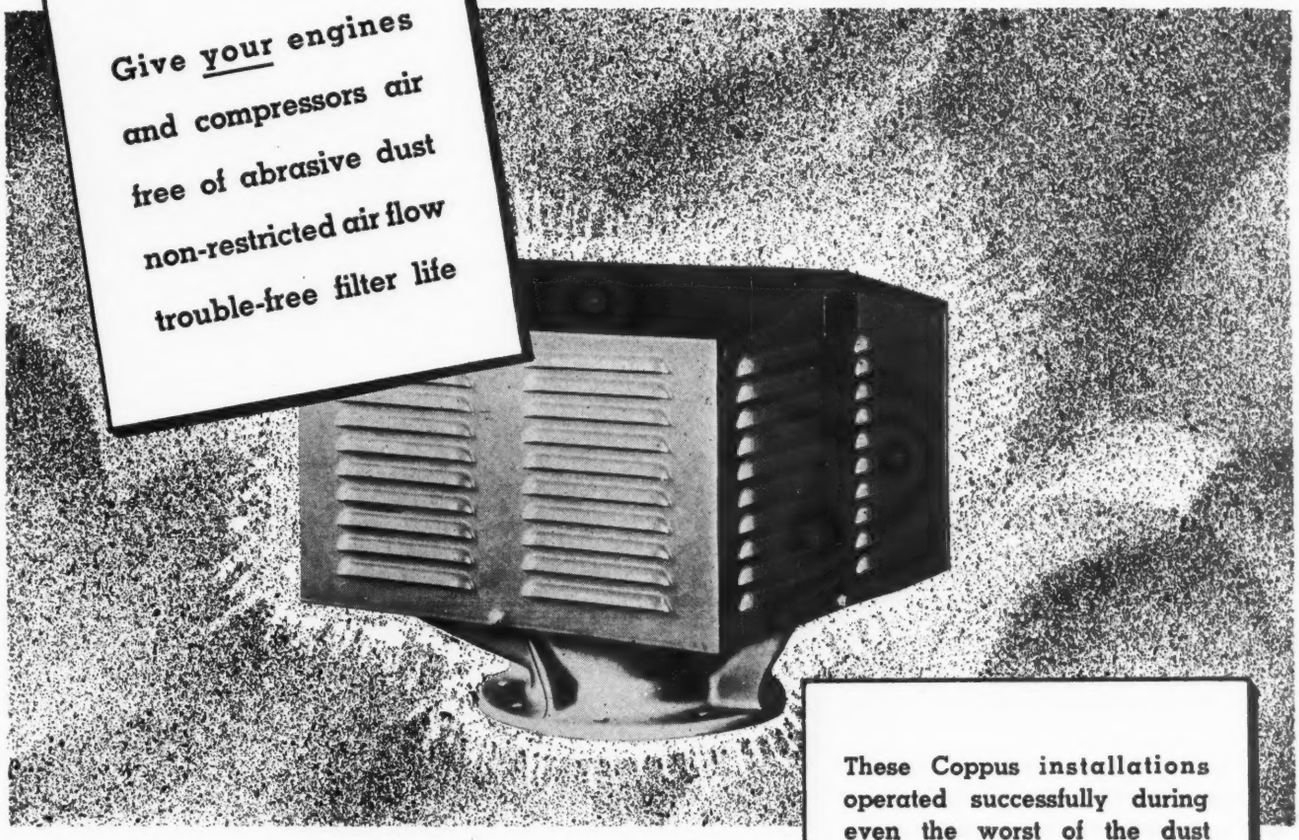

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City of Stockton, Stockton, Kansas.
Village of Sutherland, Sutherland, Neb.
City of Curtis, Curtis, Neb.
Panhandle Eastern Pipe Line, Kansas.
Atchison Topeka, Santa Fe Rlwy. Co., La Junta, Colo.
The Inland Utilities, Scott City, Kansas.
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Phillips Petroleum Co., Borger, Texas.

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"Jagabi" Speed-Measuring Instruments

q ft surface condenser. Cost about $300,000. Henrici-Lowry Engrg Co, W 10th St Bldg, Kansas City, consulting engineer.

Perry Coal Co, O'Fallon, has authorized mechanical coal-washing plant at St. Ellen mine, near O'Fallon. Cost close to $175,000.

Kansas City plans cold-storage plant and refrigerating system in new municipal market. Bond issue of $500,000 has been authorized. F C Gunn, National Fidelity Life Bldg, Kansas City, architect.

NEBRASKA — Haigler contracted Fairbanks, Morse & Co, Chicago, for two diesel-generator units, switchboard and auxiliaries for extensions in municipal power plant. Cost about $41,000. C Robert Fulton, 2327 South 19th St, Lincoln, consulting engineer.

Alliance contracted General Electric Co, Schenectady, N.Y., for 2000-kw turbine-generator and accessories for municipal power plant, at $56,535; also to Elliott Co, Pittsburgh, Pa., for surface condenser at $14,158. Awards for other equipment will be made soon. Cost about $240,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

State Board of Control, Capitol Bldg, Lincoln, has authorized plans for steam power house at state hospital at Kearney. Cost about $45,000. John Helleberg, Kearney, architect.

Franklin plans extensions municipal electric plant, to include generating unit and auxiliary equipment. Harry Robinson, city clerk.

NEW HAMPSHIRE — Plans for transferring six New Hampshire power companies to control of White Mountain Power Co are being considered by State Public Service Commission. Group comprises Alton Elect Light & Power Co, East Andover Light & Power Co, Goodrich Falls Elect Co, Hill Light & Power Co, Meredith Elect Light Co, and Pemigewasset Elect Co.

NEW JERSEY — Long Branch plans motor-driven pumping plant in connection with new sewage-treatment works. Cost over $75,000. C J Kupper, 409 East Main St, Bound Brook, consulting engineer.

NEW YORK — Beir Brothers Dept Store, 123 Falls St, Niagara Falls, plans central-heating plant and air-conditioning system in 5-story and basement store. Cost close to $200,000.

Endicott plans improvements in municipal power station. Estimates of cost being made.

F W Woolworth Co, Woolworth Bldg, New York, plans central-heating plant and air-conditioning system in new 3-story and basement store building, Charlotte, N.C. Cost about $400,000. R H Struebing, Atlanta, Ga., architect.

Westfield plans extensions in municipal power plant. Cost close to $40,000.

B F Sturtevant Co, Boston, has been awarded contract for ventilating equipment for Queens Midtown Tunnel, New York. 46 fans will be capable of supplying 178 tons of air per min, and exhausting 174 tons per min — a complete air change every minute and 25 seconds.

OHIO — Davies Packing Co, 616 W Mound St, Columbus, plans 1-story boiler house, 35 x 45 ft, at meat-packing plant. Cost close to $25,000.

City Ice & Fuel Co, 6611 Euclid Ave, Cleveland, plans rebuilding storage plant recently destroyed by fire. Loss over $125,000.

Board of Trustees, Good Samaritan Hospital, Zanesville, contracted Dunzweiler Const Co, Zanesville, for 1- and 2-story boiler house and mechanical laundry, 50 x 109 ft. Cost over $75,000.

Board of Education, Lorain, will take bids soon for 100-kw turbine-generator unit and auxiliaries power house at high school. W A Pillans, business manager.

State Dept of Welfare, State House, Columbus, plans motor-driven pumping machinery and accessory equipment, and 100,000-gal. elevated steel tank for water system at Soldiers' and Sailors' Orphans' Home, Xenia. Cost close to $30,000. J P Schooley, State Office Bldg, Columbus, state architect.

OKLAHOMA — Blackwell will soon place award for a 4000-kw turbine-generator and

Control of Boiler Water Concentration

is vital to

EFFICIENT BOILER OPERATION

When you reduce boiler efficiency you reduce plant efficiency! The Henszey Continuous Blowdown system will rid your boilers of scale, priming and foaming—and will keep them in prime condition. This control of boiler water concentration can be accomplished automatically—and *without heat loss!*

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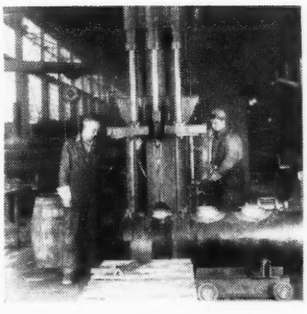

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10 East River St. Orange, Mass.

auxiliaries and 7500-sq ft surface condenser, for municipal electric plant. Cost about $400,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Benjamin Ashe, 2615 N Peoria St, Tulsa, plans compressor plant, steel tanks for storage and distribution, and welded-steel pipeline. Cost over $80,000.

Anderson & Dunham Co, Oklahoma City, plans boiler house at new cement-mixing and concrete-aggregate plant at Baton Rouge, La. Cost close to $100,000.

Anderson-Prichard Oil Corp, Ramsey Tower Bldg, Oklahoma City, plans installation of 6-, 8- and 10-in. welded-steel pipeline from vicinity of Colorado, Tex., to point near Des Moines, Iowa, about 1350 miles. Cost close to $10,000,000.

Board of Directors, Masonic Lodge, Bartlesville, will take bids soon for air-conditioning plant and system in 9-story building. W L Cassell, Telephone Bldg, Kansas City, Mo., mechanical engineer.

Barnsdall Oil Co, Tulsa, contracted White Deer Pipe Line Co, 1142 S 29th St, Oklahoma City, for steel-pipeline gathering system in Odessa, Tex., totaling about 30 miles of 2- to 12-in. pipe. Cost over $85,000.

Grand River Dam Authority, Vinita, Okla. has filed with Federal Power Commission declaration of intention to construct large dam and hydroelectric project on Grand River for flood control and power development. Installed capacity of generating plant will be approximately 80,000 hp.

OREGON — Pleasant Home Water District, 628 Spalding Bldg, Portland, Carl Goger, secretary, plans motor-driven pumping plant in connection with extensions in water system. Cost about $30,000. C E Carter, Spalding Bldg, Portland, consulting engineer.

Dept of Public Buildings, State Reconstruction Commission, Porter Bldg, Portland, plans central-heating plant in new three-story and basement state office building at Winter and Court Sts. Cost about $1,000,000. Bids on general erection close Feb. 9. Whitehouse & Price, Railway Exchange Bldg, Portland, architects.

PENNSYLVANIA — State Board of Education, Harrisburg, plans power plant for central-heating system at State Teachers' College, Edinboro. Cost close to $150,000. Richard Irvin, Starr Bldg, Pittsburgh, architect.

SOUTH CAROLINA — Board of School Commissioners, Charleston, plans central-heating plant in new 3-story junior high school. Cost $260,000. D B Hyer, and Simons & Lapham, 7 State St, Charleston, architects.

SOUTH DAKOTA — Mitchell is considering purchase of engine unit and auxiliary equipment for sewage-disposal plant station. J E Holst, city chemist, in charge.

Flandreau plans improvements in power plant of Union Public Service Co. to include two diesel-generator units of 375-hp capacity. $158,000 being arranged for entire project.

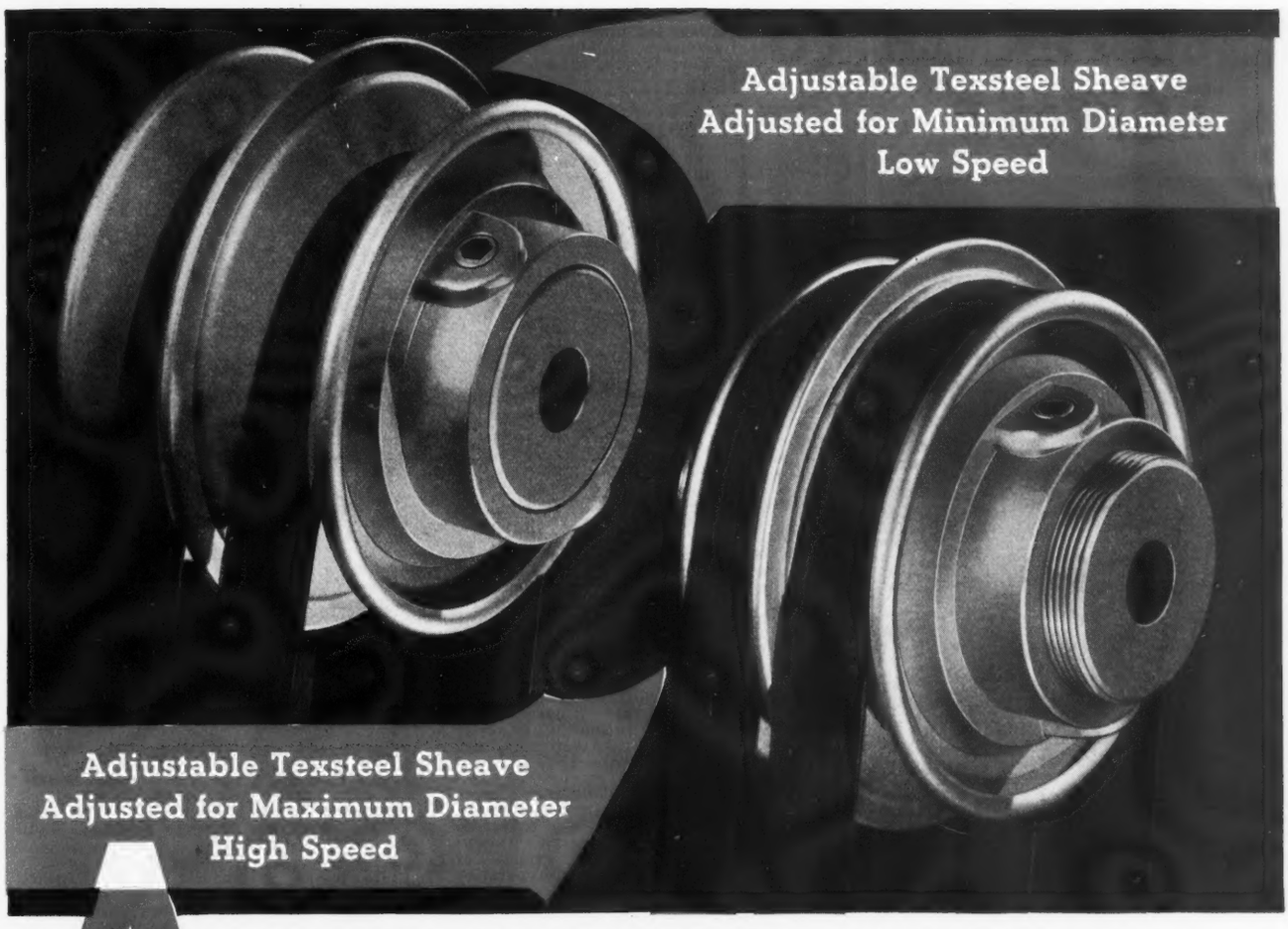
TENNESSEE — Chattanooga Gas Co, Chattanooga, is arranging 40-year franchise with city for furnishing natural gas, and will expend about $1,500,000 for extensions and improvements in system. Contract has been made with Southern Natural Gas Co, for gas supply, and welded-steel pipeline will be built for connection with that system.

Farris Hardwood Lumber Co, Nashville, plans boiler house in connection with rebuilding of portion of mill recently destroyed by fire. Loss about $100,000.

TEXAS — Willacy County Irrigation District, Raymondsville, W D Woodruff, president, contracted Dodds & Wedegartner, San Benito, for extensions in main pumping station.

Victory Petroleum Co, Abilene, J E Force, secretary, plans steel-pipeline gathering system in East Texas oil field area. Cost close to $100,000.

Southern Pipe Line Co, Corpus Christi, plans 20-in. welded-steel pipeline from plant of Southern Minerals Corp, Saxet, to carbon-black plant of Columbian Carbon Co. Extensions will be made in steel-pipeline gathering system in same field, totaling about 8 miles.



Announcing

. . . the new *TWO GROOVE ADJUSTABLE* Texsteel sheave

The Allis-Chalmers Mfg. Co., originators of variable speed sheaves, for Texrope V-Belt Drives, and pioneers of their application to fans and blowers, now offers, at low cost, a new *two* groove Adjustable Texsteel Sheave . . . in addition to the already introduced single groove Adjustable Texsteel Sheave and, for greater capacities, the Vari-Pitch Texrope Sheave.

It takes but a moment to adjust these sheaves to larger or smaller diameters, thus effecting a variation in speed of 25% to 33%. This means, that by a simple adjustment, a greater or lesser fan speed is obtained, and consequently the volume of air is precisely controlled to meet seasonal changes, or variable existing conditions. Improved design has greatly increased the strength of these sheaves and so insures silent operation permanently.

The Texrope Division of the Allis-Chalmers Mfg. Co. can now supply a complete range of sizes in variable speed sheaves for every kind of heating and ventilating application.

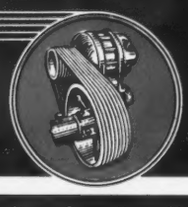
For additional information and prices write for leaflet No. 2278.

Belts by Goodrich

841

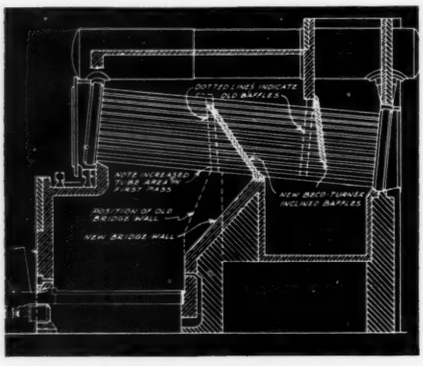
TEXROPE DIVISION

ALLIS·CHALMERS



MILWAUKEE WISCONSIN

BECO-TURNER BAFFLES


DOTTED LINES INDICATE OLD BAFFLES
NOTE INCREASED TUBE AREA IN FIRST PASS
NEW BECO-TURNER INCLINED BAFFLES
POSITION OF OLD BRIDGE WALL
NEW BRIDGE WALL

INCREASE Boiler Capacity

THE print above represents a 566 hp. boiler serving a prominent Cleveland industrial plant (name on request) which was recently equipped with Beco-Turner baffles. It clearly shows the important change in baffle design which was made by our engineering department.

Before the installation of new baffles, this boiler was normally operated at 700 hp. or about 125% of rating. With the new baffles, the boiler is normally operated at 900 hp. or about 160% of rating. Peak loads as high as 225% of rating have been carried since the change.

Beco-Turner baffles increase efficiency and multiply capacity because (1) they can be installed at any angle and in any shape necessary to give the highest degree of heat absorption and because (2) they remain absolutely gas tight, due to their patented expansion joints. They bring about more uniform gas velocity, lower flue gas temperatures, and reduced fuel consumption.

Free Engineering Service

Why not investigate the possibility of saving fuel and increasing capacity through more advanced baffle and furnace design? Upon receipt of blueprints, we will gladly submit any possible recommendations that will increase efficiency and capacity. Mail coupon for complete catalog.

PLIBRICO JOINTLESS FIREBRICK CO.

Nation-Wide Boiler Setting Service

BAFFLE DEPT., CHICAGO, ILL.

MAIL COUPON FOR FREE CATALOG

Plibrico Jointless Firebrick Co.
1818 Kingsbury St., Chicago, Ill.

Please mail Beco-Turner catalog.

Firm .....

Address .....

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Name ..... Title .....

Send blueprints and our engineering department will gladly suggest any possible recommendations for improving your baffle design. P2-38

Caldwell contracted E L Dalton, Dallas Bank Bldg, Dallas, for butane-gas system for municipal service at $34,840. J J Rady, Majestic Bldg, Fort Worth, consulting engineer.

Red Bluff Water Power Control District, Pecos, E B Barron, president, contracted Brown & Root, 708 Colorado St, Austin, at $95,175, for power plant for rural electric system, including diesel-generator units and accessories. J B Shaw, engineer.

Treasury Department, Washington, D.C., plans central-heating plant in new public-health service building at Fort Worth. $1,300,000 has been arranged.

Board of Education, Dallas, plans central-heating plant in new high school South Dallas. Cost about $275,000. W C Sharp, Construction Bldg, Dallas, architect.

R F Ball Construction Co, Fort Worth, received general contract for power house for West Texas State Hosp, Big Springs.

VERMONT — Board of Education, Ludlow, plans central-heating plant in new 2-story high school, for which general contract has been let to Casper Ranger Construction Co, 6 Newton St, Holyoke, Mass. Cost about $140,000.

VIRGINIA — Winchester Woolen Co, Winchester, has approved plans for new steam power house at mill. Cost close to $35,000.

Dry Fork Milling Co, Dry Fork, plans boiler house in connection with rebuilding of feed-milling plant recently destroyed by fire. Loss about $75,000.

Board of Directors, Norfolk General Hospital, Norfolk, will award contracts soon for boiler plant at institution. Cost about $40,000. G A Peple, Jr, American Bldg, Richmond, consulting engineer.

S C Foster, Richmond, plans hydro generating plant in Meadow Creek Mountain district, near Newcastle, to be constructed by M E Marcus interests for power supply for rural transmission system of Craig-Boutetourt Electric Co-operative Inc, Maggie. Cost over $100,000.

South Norfolk has authorized plans for municipal electric plant, and will begin work in Janusry. Cost about $330,000. Wiley & Wilson, Peoples National Bank Bldg, Lynchburg, consulting engineer.

WASHINGTON — Washington National Guard, Adjutant General's Office, Camp Murray, Fort Lewis, plans central-heating system in 4-story and basement armory building, Seattle, Wash. Cost $775,000. A M Young and A F Naramore, Central Bldg, Seattle, associated architects.

S A Moffett Co, Florence, plans refrigerating equipment in addition to fruit and vegetable processing and canning plant. Cost close to $45,000. H A Hinricks, general manager.

Orcas Power & Light Co, East Sound, has low bid from LePage McKenny Co. Seattle, for two diesel-generating units at $29,737, and will award contract soon. T C Smith, Henry Bldg, Seattle, consulting engineer for plant.

Northwestern Natural Gas Corp, Toppenish, plans installation of local butane-gas plant, to supplement natural-gas supply now being secured from Benton County gas field area. Cost about $45,000.

Anacortes Plywood Co, Inc, Anacortes, plans better plant in connection with 1-story woodworking mill. Cost over $85,000. J J Lucas, vice-president and general manager.

WEST VIRGINIA — Kanawha County Board of Education, Charleston, plans central-heating plant in 2-story West Side high school. Cost about $450,000. Warne, Tucker & Silling, Masonic Temple Bldg, Charleston, architects.

Morgan County Board of Education, Nerkeley Springs, plans central-heating plant in new 2-story high school. Cost about $180,000.

WISCONSIN — Manitowoc Cold Storage Co, Manitowoc, has acquired former lcoal plant of Riverview Brewery Co, and will remodel and equip for new cold-storage plant. Cost over $45,000, with equipment.

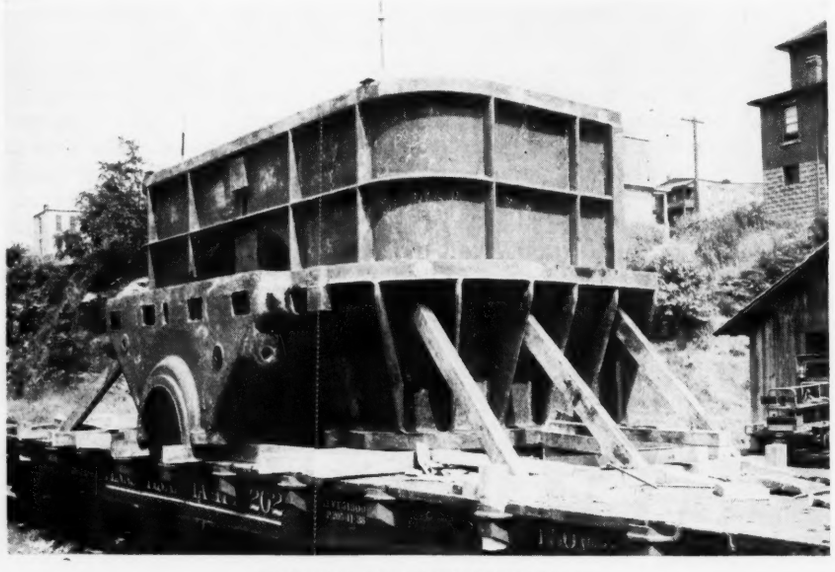
Wisconsin Cheese Producers' Federation, Marshfield, plans 1-story cold-storage and refrigerating plant. Cost about $45,000.

State Board of Normal School Regents, State Office Bldg, Madison, contracted James Leck Co, 211 S 11th St, Minneapolis, for boiler plant for central steam-heating service at State Teachers' College, La Crosse, at $95,000. Arthur Peabody, Madison, state architect.

State Board of Normal School Regents, Madison, E G Doudna, secretary, plans central-heating plant, 3-story, 45x85 ft, at State Teachers College, La Crosse. Cost about $100,000. Arthur Peabody, Capitol Bldg, Madison, state architect.

WYOMING — Owl Creek Irrigation District, Thermopolis, Charles M Smith, superintendent in charge, plans large pumping station on Big Horn River for irrigation service. Cost about $60,000.

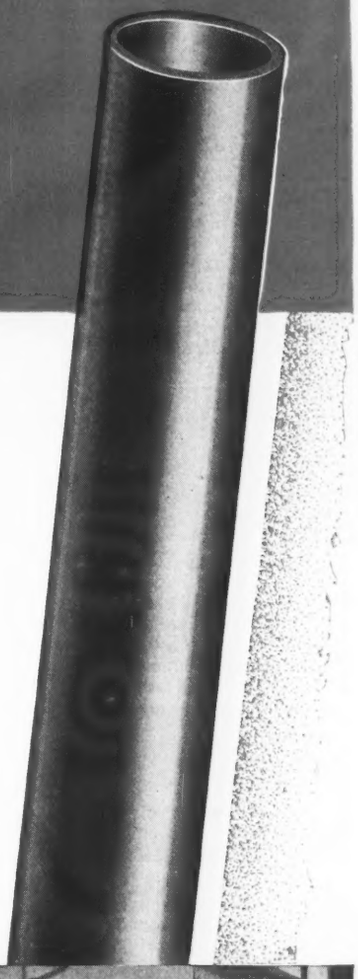
HAWAII — Bureau of Yards and Docks, Navy Dept, Washington, D.C., contracted Max W Moody Co., Honolulu, at $34,750 for standby electric power plant at naval station at Oahu, T. H.



CASTING FOR STEAM TURBINE

Steam-turbine cylinder base casting, one of the largest made of the Trafford Foundry of the Westinghouse Electric & Mfg Co. Shipping weight of the trimmed casting is 88,700 lb

FORECAST for 1938

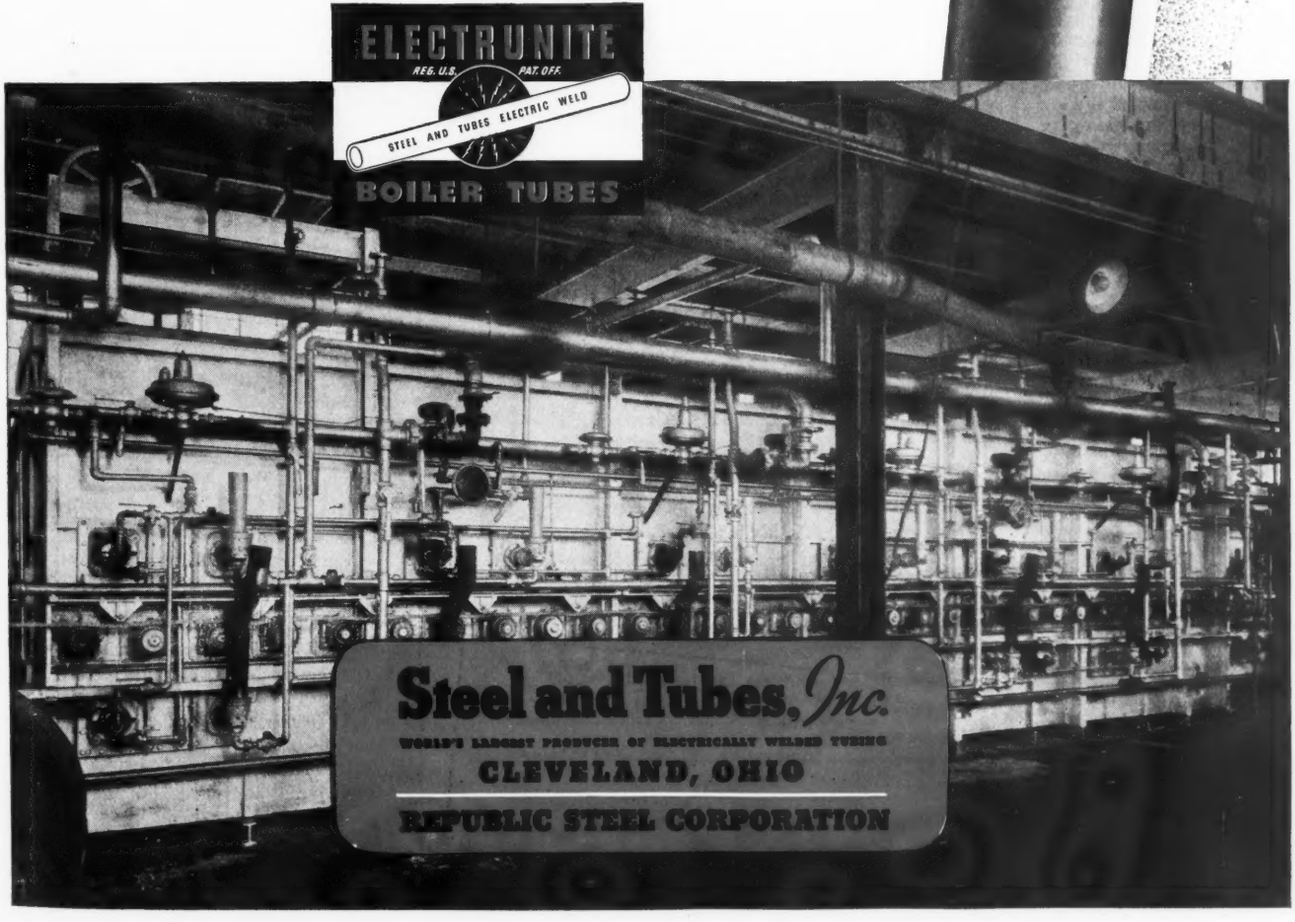


● For ELECTRUNITE and for users of this modern boiler tube, the future looks bright.

Manufacturers and owners of boilers will be assured of uniformity, high quality, safety and lower installation and maintenance costs through their use of ELECTRUNITE.

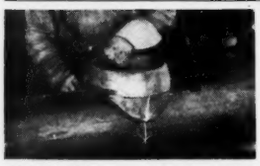
According to the expected demand—based on footage figures which have grown steadily year after year—ELECTRUNITE will enjoy another year of increasing popularity. In anticipation of this and to protect customers, the new controlled atmosphere annealing furnace, shown below, has been installed together with new welding equipment. Building space for finishing operations, inspection and storage has been increased substantially.

Ask us to send you the full story on ELECTRUNITE boiler and condenser tubes and how they can make 1938 a more profitable year for you.



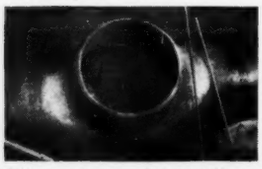
WELDOLETS · THREDOLETS

. . . Welded Outlets for Piping . . .



WeldOlets and ThredOlets are easily installed. Simply select the position of the outlet, rub the fitting over the pipe several times to remove scale, mark center lines and tack the WeldOlet or ThredOlet into position.

The WeldOlet or ThredOlet is then welded into place either by the electric-arc or oxy-acetylene method. A junction of full pipe strength and an outlet that is leak-proof is the result.



Where the outlet is 2" or larger, it is recommended that the button be removed after the welding operation. On small sizes, the fitting is used as a templet and the hole is cut in the main pipe first. A full inspection of the inside of the joint is possible by using these fittings, allowing removal of all scale, welding metal, etc.

The branch line is then welded into position using a simple Vee weld. In the event that a ThredOlet is used the branch pipe is threaded and screwed into place. The result is a junction of full pipe strength, absolutely leak-proof with turbulence and friction reduced to a minimum.

The Modern Method of Making Branch Connections

BONNEY WeldOlets and ThredOlets provide the modern method of making branch pipe connections by welding.

They eliminate all cutting, threading and fitting of the main pipe. No templets are needed. The illustrations to the left show the ease with which they are installed.

WeldOlets and ThredOlets produce leak-proof joints of full pipe strength. Their funnel shaped outlets reduce turbulence and friction to a minimum. Available from stock with outlets from 1/4" to 12" for all standard pipe sizes, they cost no more than ordinary fittings and much less to install.

Stock fittings are of drop-forged steel, but special applications sometimes require special materials. They can be made of Toncan iron, wrought iron, brass, Everdur, Monel, Stainless Steel, in fact any metal that can be forged.

Once seen, their advantages are obvious. To show them to you we'd like to send a sample—no obligation, of course. Sign the coupon and attach to your company letterhead, and you'll use them on your next piping job.

The names "WeldOlets and "ThredOlets" are Bonney trade marks registered in the United States Patent Office. Full patent coverage has been granted in the United States and foreign countries.

BONNEY FORGE & TOOL WORKS
Forged Fittings Division
ALLENTOWN, PA.
Stocked by Leading Distributors

Bulletin WT23 tells the complete story about WeldOlets and ThredOlets. The coupon will bring your copy and a sample trial fitting. Mail it today.

MAIL COUPON TODAY →

Yes, I'd like a sample WeldOlet or ThredOlet. Also send Bulletin WT23 and name of nearest distributor. P-28

Name .....

St. & No. .....

City & State .....

POWER LINES

(continued)

RUDOLPH WINTZER, associated with Nordberg Mfg Co, Wilwaukee, Wis, for more than 25 years, died in Dec, 1937. In 1924, Mr. Wintzer was appointed chief engineer, continuing in that capacity until 1935, when he was succeeded by his assistant, Emil Grieshaber. Since 1935, he served as consulting engineer in an advisory capacity on engineering problems.

PERSONALS

GANO DUNN, president of J G White Engineering Corp, New York, N.Y., has been awarded the 1937 Thomas A Edison Medal of the American Institute of Electrical Engineers. The award, made "for distinguished contributions in extending science and art of electrical engineering, in the development of great engineering works, and for inspiring leadership in the profession", was made Jan 26 at the winter convention of the Institute.

R A MCCARTY has been appointed manager, Small Motor Div, Westinghouse Elect & Mfg Co. Mr. McCarty was manager of Power Engrg Dept from 1930

to 1935, and then manager of the Generator Div. F H Stohr succeeds Mr McCarty as manager of the Generator Div.

J E MACMAHON, formerly assistant sales manager, has been appointed general sales manager of Graton & Knight Co, Worcester, Mass., to succeed C O Drayton, recently resigned.

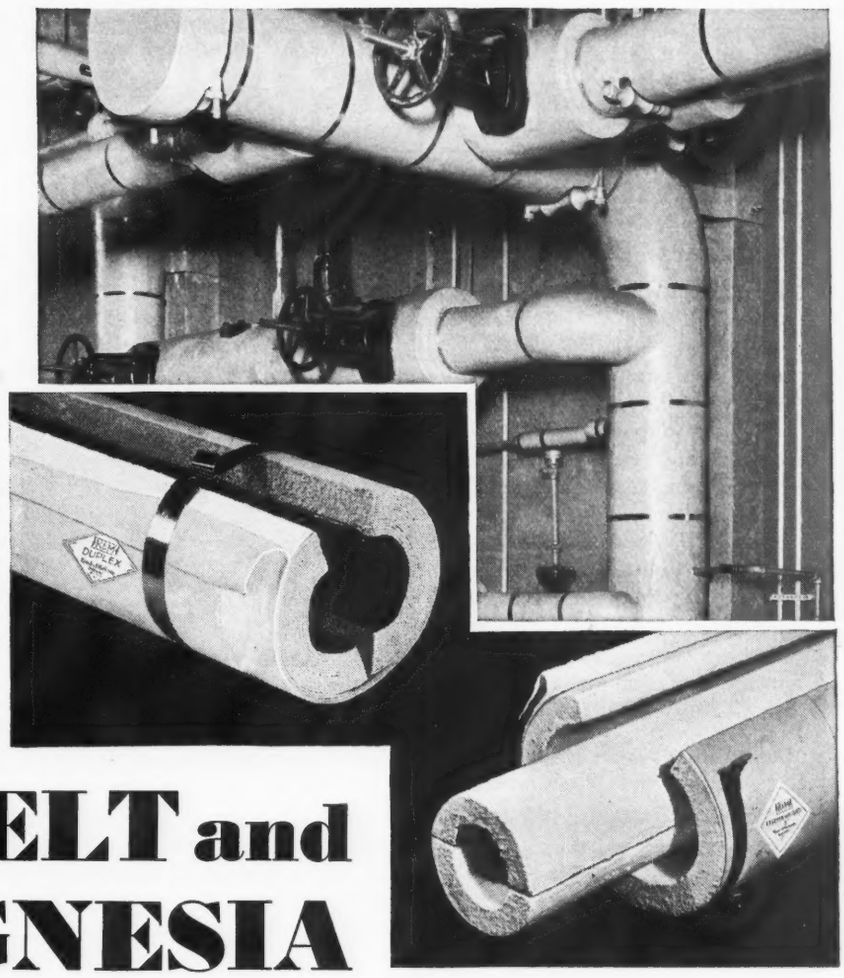
NATHAN R BIRGE, assistant to president of General Electric Co since 1927, has been elected a vice-president.

C V BRENNAN was elected president of Professional Engineers' Assn of B.C. at their 18th annual meeting held recently at the Hotel Georgia, Vancouver, B.C. P L Lyford was named vice-president. Council members for this year are C E Webb, representing civil engineers; F W McNeill, electrical; S J Crocker, mechanical; and F B Freedland, mining.

THOMAS A MARSH, Iron Fireman Mfg Co, Chicago, Ill., has been appointed a member of the ASME subcommittee which will cooperate with the Consum-

For insulating efficiency...

K&M



DUPLEX WOOL FELT and 85% MAGNESIA

85% Magnesia is the accepted standard by which the efficiency of other forms of insulation is judged. For temperatures up to 600°F., it offers lasting effectiveness for it is resistant to unusual conditions such as water leakage and steam.

For hot and cold water lines, K & M Duplex Wool Felt has many advantages. It is protected by a special inner lining of asbestos felt impregnated with a waterproofing compound. Withstands heat up to five pounds of steam. Made of a continuous wrapping of specially creped wool felt which gives it an exceedingly low thermal conductivity.

K & M "Featherweight" 85% Magnesia and K & M Duplex Wool Felt are backed by more than 60 years' experience with insulation materials. The K & M line is complete, and priced right.

Send for information

- ☐ "Featherweight" 85% Magnesia Pipe Insulation, Blocks and Lagging
- ☐ Wool Felt Pipe Insulations
- ☐ Air Cell Insulations; sections and blocks
- ☐ Asbestos Pipe Insulations in sections
- ☐ Asbestos Insulation in sheets and blocks
- ☐ Asbestos Insulating Cements
- ☐ Asbestos Packings; rope, cord and sheet
- ☐ Asbestos Gaskets, Gasket Tapes and Cloth
- ☐ Friction Materials

Check the products on which you want full information and mail this coupon today.

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KEASBEY & MATTISON COMPANY
AMBLER, PENNA.

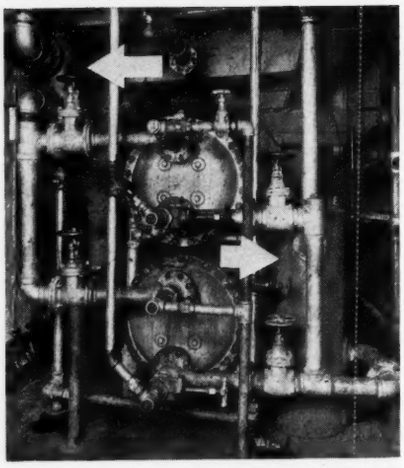
KIRKALDY SYSTEM

Non-Chemical

Eliminates Scale, Corrosion and Slime

in Boilers, Economizers, Heaters, Condensers, etc.

Boilers and heaters badly scaled, even with the heaviest calcium and silica deposits, are quickly cleaned and kept in efficient operating condition by the Kirkaldy System. Condensers suffering from slime and algae deposits are just as definitely protected. As long as the System continues in operation neither scale nor slime can accumulate on the surfaces protected, nor can CORROSION take place.



Installation of Kirkaldy System recently made in the Power Plant of a prominent Eastern Milk Company.

The Kirkaldy System is the only practical and economical method of achieving both these results. *Write for Bulletin No. PB 37-2.*

ELECTROLYTIC METAL PROTECTION INC.

247 PARK AVENUE NEW YORK, N. Y.

Figure it out for yourself
WHICH TAKES LONGER
A few quick DAUBS *with a*
BRUSH — *or*
CUTTING OUT A GASKET?

SEAL ALL

Daubed on with a brush—replaces expensive gaskets . . . and lasts longer!

Cuts Labor and Maintenance Costs . . . Withstands highest Pressures . . . Won't Blow Out!

For Turbine joints, threads, flanges, etc. —sealing *All* joints tightly!

Economy and lastingness proved by leading Power Plants, Ship Builders, Steamships, Railroads, U. S. Navy, Public Utilities . . . and wherever tightly sealed joints are vital.

DAUB JOINTS TIGHT WITH SEAL-ALL AND SAVE MONEY!

Write for full details.

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ers' Counsel in considering activities of the National Bituminous Coal Commission.

J R A HOBSON, project engineer for the PWA on Danville, Va.'s, hydroelectric plant, has been named engineer for the High Point power project on the Yadkin River.

BUSINESS ITEMS

ALLEN-BRADLEY Co, Milwaukee, Wis, has moved its Cincinnati Office to larger quarters at 2331 Reading Rd. W L Jaeckel is district manager.

NORTON Co, Worcester, Mass, has appointed Robert M Onan salesman for refractories section of Abrasive Div. He will make his headquarters in Chicago, and will cover Illinois, Wisconsin, upper Michigan, Indiana, and Missouri.

BRIDGEPORT BRASS Co, Bridgeport, Conn, has opened three new branch offices at 701 Volunteer Bldg, Atlanta, Ga.; 715 N Van Buren St, Milwaukee, Wis.; and 1319 Gulf Bridge, Pittsburgh, Pa.

ROOTS-CONNERSVILLE BLOWER CORP, Connersville, Ind., has appointed J G Kelly, Inc, 210 E 45th St, New York, N.Y., sales agent for boiler-service units in metropolitan New York. Also, Frank A Kristal, 30 Church St, New York, will handle sales of turbine pumps for industrial applications.

LAMINATED SHIM Co, INC, Long Island City, N.Y., has appointed Industrial Sales & Engrg Co, Houston, Texas, sales agent in the Southwest.

A O SMITH CORP, Milwaukee, Wis., has opened a new district office in the Gulf Bldg, 439 7th Ave, Pittsburgh, headed by R L Howes.

PITTSBURGH PIPING & EQUIPT Co, Pittsburgh, has appointed Garrett Burgess, Inc, Woodbrook Bldg, Detroit, Mich, as district representative.

ROOTS-CONNERSVILLE BLOWER CORP, Connersville, Ind., has anounced appointment of Buffalo Mill Supply Co, Buffalo, N. Y., and F W Allen & Son, Erie, Pa., as distributors for turbine pumps.

LINCOLN ELECTRIC Co, Cleveland, Ohio, has opened a new sales office in Phoenix, Ariz., under the direction of R J Rearson.

FEDDERS MFG Co, Buffalo, N. Y., has appointed Hayes Selling Co, Inc, Philadelphia, Pa., as representative for unit heaters and air-conditioning equipment.

VACUUM SYSTEMS, INC, was recently formed with headquarters at 436 The Arcade, Cleveland, Ohio. The company has acquired the assets of the Crescent Pump Co, Detroit, Mich., who formerly manufactured the Crescent "Roto-Piston" dry vacuum pumps. Officers of the new company are Louis H Mesker, president; B E Hathaway, vice-president; H W Dosey, vice-president; and W L Holoway, secretary.